MCFRS In-Service Training Program

BASEMENT AND CELLAR FIRES

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BASEMENT AND CELLAR FIRES

I. OVERVIEW

From a firefighting perspective, basement and cellar fires are some of the most challenging and dangerous situations encountered inside a building. Due to their location, they have limited access, limited ventilation, and drainage problems from nozzle flow. They may be places for unused hazardous storage such as pesticides, varnishes, and paint products.

They can be either large, open, unfinished areas or small cut-up, partitioned spaces that can trap and disorient firefighters or victims as well under smoke conditions. Unprotected steel or lightweight wooden floor joist supporting the first floor can fail creating a major catastrophic event for firefighters. Essentially, when descending down the interior stairs of a basement or cellar fire, the nozzle team will experience extreme heat while passing through thermal layers to reach the seat of the fire.

MCFRS recognizes the danger in attacking basement and cellar fires in this manor and has added section 10, *MCFRS Standard Operating Procedures for Safe Structural Firefighting Operations,* to direct suppression crews in an alternative approach. This module will attempt to focus on tactical considerations for basement and cellar fires as well as review of the MCFRS SSFF SOP on basement fires.

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II. OBJECTIVES

Operational personnel will be able to:

- Understand the differences in terminology describing various types of below grade construction
- Recognize and identify specific hazards associated with below grade fires
- Understand strategic objectives in controlling fires in these occupancies
- Review section 10 of the SOP for Safe Structural Firefighting Operations
- Identify unsafe practices and tactical errors of past incidents involving basement fires after reviewing selected NIOSH Firefighter Fatality reports

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III. CRITICAL DISCUSSION POINTS

A. Differences in Terminology

1. Crawl Space – a small space beneath the lower floor of a structure that allows access to wiring or plumbing. Typically, the crawl space between the first floor and the excavated ground is not high enough for a person to stand upright. There are, with some construction, vents on the outside of the structure that allow for air movement into these crawl spaces.

2. Basement – typically a full story below grade; one half or more of its height is above grade. A basement having its sides and rear excavated will have more window and door openings for ventilation, access and egress, and rescue.

3. Cellar – a below grade area that has more than half its height below ground. Usually cellars that are completely below grade have no windows with one or two stairways for access (interior and exterior).

4. Sub cellars – an underground level below that of a cellar. A sub cellar possesses only one interior entrance with no windows. It is possible for a structure to have three below-grade levels; basement, cellar, and sub cellar.

B. Doorways

1. Interior basement and cellar doors in residential and multi-family structures will usually be located beneath the stairs of the upper floors.

2. In single story residential structures (ramblers or ranchers), interior basement entrances will often be found in the kitchen.

3. In single family residential structures that have split foyers, access to the basement is usually just inside the front entrance.

4. In commercial properties, exterior entrances can be in the front or back of the building with either stairs leading to a doorway at the bottom or a doorway opening to stairs leading to the basement.

5. Commercial and/or residential properties may have an exterior entrance to a cellar or basement that has metal doors flush with the ground or pavement.

6. Commercial and/or residential properties may also have metal lift-type doors positioned on the side or rear of these properties.

C. Recognition of a Basement Fire

1. The presence of heat and smoke at the first floor level, or on all floors, and the absence of visible flames may indicate a basement fire.

2. When initiating a circle check or 360, smoke coming from window wells at the basement level would be an obvious sign.

3. Smoke emitting from the baseboards of lower floors and banking down may indicate a below grade fire.

4. A well involved basement fire in balloon frame construction may present itself not only in the basement, but the attic as well due to open chases and the lack of fire-stopping.

D. Hazards Associated with Basement or Cellar Fires

1. When descending the interior stairs of a basement fire in residential structures, the fire may reduce the structural integrity of the interior stairs as well as the floor joist supporting the first floor.

2. Never use an elevator to descend to the cellar of a commercial or residential structure during an investigation or working incident. The elevator may place you into the heart of a major blaze. Firefighters may find themselves trapped and without knowledge of alternative exits or a position of retreat.

3. Whether residential or commercial, basements and cellars may have storage materials such as boxes, combustibles, and flammable liquids. Compartmentalized basements can hinder the attack line advancement to the seat of the fire.

4. In commercial occupancies, racked storage can fall, disorient, or trap firefighters. Racked storage can also inhibit hose streams directed at the ceiling (**there should be a minimum of 36" between sprinkler heads and racked storage in sprinkler protected buildings; *Chapter 22 Montgomery County Fire Safety Code***).

5. Broken gas lines can create an explosive hazard for firefighters.

6. When flowing water in large quantities or for an extended period of time, water may collect in the basement due to reduced drainage. After any basement or cellar fire is extinguished, several inches to a foot of water can be found. A firefighter trapped in the cellar or basement that is disoriented or unconscious could drown.

E. Strategy and Tactics

1. Complete a circle check or 360.

2. Ensure that all sprinkler connections have been supplied if applicable; this will greatly assist in controlling fire growth.

3. When an attack from the exterior entrance has been elected, a hose line must still go to the interior stairs for:

- Protection of occupants and search crews during the primary search
- Protection of the interior stairs by preventing fire extension up from the basement (*the hose stream should never be directed down into the basement but rather used as a curtain at the entrance if the door is inoperable*)

There must be a verbal acknowledgement of strategy between interior and exterior attack crews before commencement giving interior crews time to achieve position and to prevent opposing hand lines.

4. If there in no exterior entrance and the attack must be made from the interior stairs once deemed tenable:

- there must be enough hose to reach the seat of the fire
- descending the stairs must occur rapidly to reduce exposure
- there must be good hose line management to permit an aggressive attack at the seat of the fire; another firefighter should be positioned at the top of the stairs to assist with hose advancement
- there must be a verbal acknowledgement of the strategy between interior and exterior attack crews before commencement

5. If it is impractical to enter the basement or cellar, there are other methods that may be used to knock down the fire:

- Find the hottest area of the first floor, cut a hole between the floor joist, then insert a cellar or distributor nozzle
- Use a defensive attack from a basement window or opening
- "Flowing the floor" is a technique used when the first floor becomes too dangerous because of smoke or collapse. The object is to cover a porous floor with several inches of water with hopes that it will seep thru the flooring to help extinguish the fire. IT'S A LAST RESORT!

- The use of high expansion class A foam

6. Ventilation – must be coordinated with the interior attack. If available, all openings at the below grade level must be ventilated to permit advancement of the interior attack.

7. If there are no basement level openings, an alternative method of ventilation could include cutting a hole on the first floor just beneath a window. The opening should be the width of the window and extend out approximately one foot. A ventilation fan may then be placed in the window in the exhaust mode or a hose line can be used to hydraulically vent the structure.

8. A basement or cellar fire in a commercial occupancy that has showcase windows offers an additional means of ventilating the basement. The showcase flooring is typically constructed of plywood; remove the showcase glass windows then open the flooring to ventilate the cellar.

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IV. MCFRS SOP FOR SAFE STRUCTURAL FIREFIGHTING OPERATIONS, SECTION X. ON BASEMENT FIRES IN SINGLE FAMILY, DUPLEX, AND TOWNHOUSE STRUCTURES

A. Effective size-up and communication at a basement fire are critical to the success of this operation. The location and extent of the fire, the type of building construction, and points of access to the basement must be determined early. If the fire is known to be in the basement, the first arriving engine officer must quickly determine if there is an exterior access to the basement by checking for a basement entrance visually, or based on reports from other **units**. An exterior door most often will be in the rear of the structure.

B. When attacking a basement fire, the objectives are to protect the primary search, and to keep the fire from extending vertically by containment and extinguishment.

C. Normally, the first due engine **crew** will stretch the first line to the first floor to contain the fire, and protect the occupants and searching firefighters by closing the basement door and/or using a hose stream aimed at the ceiling over the stairway. ***THIS HOSE STREAM MUST NOT BE DIRECTED DOWNWARD INTO THE STAIRWELL***. The officer advancing this line must carefully size up the structure s integrity when determining whether the line should be positioned at the top of the stairs, or from a position closer to the entrance door. The first due **unit officer** must notify the **IC** when this hose line is in place, and confirm that the **crew** is maintaining its position on the first floor.

D. The **IC** will direct the second or third due engine **crew** to advance a hose line to the exterior basement doorway for attack. The **IC** will ensure that the engine **crew** with the attack line at the exterior basement entrance does not begin the attack until the first line is confirmed to be in position and ready, and the first due engine **crew** has confirmed that it is not advancing down the basement stairs.

E. If the first due engine **crews** position becomes untenable and it cannot hold its position on the first floor, the **crew** must notify Command so that any **crews** operating above it can evacuate before the engine **crews** withdrawal. The engine **crew** will

then take a position outside, normally at the main entrance, and attempt to prevent the fire from extending to the rest of the dwelling from that location until the basement fire can be knocked down. The **IC** will also consider removing the **crews** from positions above the basement once the primary search is completed, even if the basement fire is not under control. The first arriving engine officer and/or the **IC** will also consider taking this position initially (and delaying the primary search) during fires in heavily involved basements, especially in dwellings of lightweight construction.

F. Basement fires sometimes must be extinguished with the first attack line advanced down the interior stairs, if an exterior entrance into the basement is not accessible, or if there is no exterior entrance at all. The first due engine officer must first determine if it is safe to descend the basement stairs for a direct attack on the fire by evaluating the structure s stability, the life hazard, and the fire and heat conditions at the top of the stairs. If attack will begin through the interior basement stairs, the officer will transmit this information to the **IC**, who will then ensure that no other hose lines are advanced through, or operated into, any exterior basement openings from opposing positions.

G. If the interior basement stairs cannot be used for an attack, and there is no outside basement entrance, the **IC** will direct **crews** to other available alternatives.

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V. REVIEW QUESTIONS

A. What is the definition of a cellar?

B. What is the difference between a cellar and a sub-cellar?

C. What is the difference between a basement and a cellar?

D. List three ways of recognizing a basement or cellar fire.

E. Describe the locations of interior stairways to basements in residential, single family structures.

F. Identify three hazards associated with below grade fires.

G. What must be established if the initial attack is to be made from the exterior entrance to the basement?

H. List two considerations for initiating an interior stairway attack on a basement or cellar fire.

I. List three defensive approaches to attacking a basement or cellar fire.

J. According to the MCFRS SSFF SOP, what is the mission of the first attack line into the structure?

K. According to the MCFRS SSFF SOP, when an attack from the exterior entrance is elected, who is responsible for initiating the attack from that position?

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VI. NIOSH FIREFIGHTER FATALITY CASE STUDIES

Two Fire Fighters Die and Two Are Injured in Townhouse Fire—District of Columbia

SUMMARY

On May 30, 1999, fire fighters responded to a box alarm involving a townhouse fire. The initial report came in as a house fire, and it was later reported that the fire was in the basement (all fire fighters did not receive the follow-up report of fire in the basement). Engine 26 (Lieutenant and 3 fire fighters) was the first to arrive on the scene and reported smoke showing on the front (side 1) of a row of townhouses (see Diagram 1). A fire fighter (Victim #1) from Engine 26 advanced a 1½-inch attack line through the front door (1st floor). Soon after, the layout man from Engine 26 entered to back up Victim #1. Engine 17 (Lieutenant and 3 fire fighters) arrived shortly after and stretched a 350-foot 1½-inch hose line to the rear (side 3) (see Diagram 1). Truck 15 (Captain and 3 fire fighters) arrived on the scene and began ventilation on the front. Truck 4 (Lieutenant and 3 fire fighters), responding for Truck 13 (out of service), arrived later and began ventilation in the rear. Engine 10 (Lieutenant, Victim #2, and 2 fire fighters) arrived on the scene as the third-due engine and backed up Engine 26 on side 1. Engine 12 arrived as the fourth-due engine and proceeded to side 1 of the building. Battalion Chief 1 (the Incident Commander [IC]) and Rescue 1 (Lieutenant and 4 fire fighters) also responded as a part of the box alarm.

Engine 26 and Engine 10 advanced their lines through the front door in a search for the fire and the basement door (at the top of the basement steps). As the two crews searched, Truck 4 made forcible entry through a sliding-glass door in the rear (basement entrance door at ground level). Engine 17 (at the basement door with a charged line) reported to the IC that they were on the first floor, in the rear, with a small fire showing (Engine 17 was actually at the basement level). Engine 17 radioed the IC for permission to open their line and knock down the fire. Knowing that he had two engine crews on the first floor in the front, the IC denied Engine 17's request until he could locate the interior crews' positions. He radioed the officer from Engine 26 several times for their position, but received no response.

Engine 17 asked a second time for permission to hit the fire, as it began to grow. The IC denied the request a second time and again tried unsuccessfully to radio the officer from Engine 26. Conditions in the interior rapidly deteriorated, forcing the fire fighters on the first floor to search for an exit. A fire fighter in the interior recalled seeing fire appear from a doorway on the first floor. After seeing the fire, the fire fighter stated that everything went black and he felt an intense blast of heat. Victim #1 and Victim #2 were unable to escape, while the Lieutenant and a fire fighter from Engine 26 escaped with severe burns. All injured fire fighters were transported to a local hospital. The Lieutenant and fire fighter were admitted with burn injuries. Victim #1 was treated for severe burns and was pronounced dead the following day. Victim #2 was pronounced dead on arrival at the hospital.

NIOSH investigators concluded that, to minimize the risk of similar incidents, fire departments should:

- ***ensure that the department's Standard Operating Procedures (SOPs) are followed and refresher training is provided***
- ***provide the Incident Commander with a Command Aide***
- ***ensure that fire fighters from the ventilation crew and the attack crew coordinate their efforts***
- ***ensure that when a piece of equipment is taken out of service, appropriate back up equipment is identified and readily available***
- ***ensure that personnel equipped with a radio position the radio to receive and respond to radio transmissions***
- ***consider using a radio communication system that is equipped with an emergency signal button, is reliable, and does not produce interference***
- ***ensure that all companies responding are aware of any follow-up reports from dispatch***
- ***ensure that a Rapid Intervention Team is established and in position immediately upon arrival***

- ***ensure that any hose line taken into the structure remains inside until all crews have exited***
- ***consider providing all fire fighters with a Personal Alert Safety System (PASS) integrated into their Self-Contained Breathing Apparatus (SCBA)***
- ***Develop and implement a preventive maintenance program to ensure that all SCBAs are adequately maintained.***

INTRODUCTION

On May 30, 1999, two fire fighters died and two were injured while battling a townhouse basement fire. Two fire fighters—Victim #1, a 30-year-old nozzle man from Engine 26, and Victim #2, a 29-year-old nozzle man from Engine 10—had to be rescued when interior crews were hit by an intense blast of heat and flames. Victim #1 was rescued and transported to a nearby hospital where he was pronounced dead the following day. Victim #2 was rescued and pronounced dead on arrival at the hospital.

On June 1, 1999, the International Association of Fire Fighters notified NIOSH of the incident, and on June 21, 1999, a Safety and Occupational Health Specialist, the Senior Investigator, and the Team Leader of the NIOSH Fire Fighter Fatality Investigation and Prevention Program, initially investigated this incident. On July 21, 1999, a Safety and Occupational Health Specialist and a Safety Engineer conducted additional interviews. An Engineer and a Physical Scientist from NIOSH also completed an evaluation of the department's SCBA maintenance program on July 21, 1999. On August 31, 1999, a Safety and Occupational Health Specialist returned to interview the seriously injured fire fighter. Meetings and interviews were conducted with: the Chief, the Assistant Chief, the two Battalion Chiefs on the scene (one of whom was the Incident Commander), fire fighters on the box alarm, the department safety officer, and the investigation team from the fire department involved in the incident. Representatives from the personal protective equipment manufacturer, the National Institute of Standards and Technology (NIST) who evaluated the victims' personal protective equipment and will be developing the fire growth data for the department, the metropolitan police, and the owner of the townhouse were also interviewed. Copies of photographs, training records, Standard Operating Procedures (SOPs), the reports completed by fire department investigators, the autopsy reports, and the floor plan of the townhouse were obtained. A site visit was conducted and photographs of the fire scene were taken.

The fire department involved in this incident is comprised of 1,764 total employees, of whom 1,182 are uniformed fire fighters. The department serves a population of approximately 1 million in a geographic area of 69 square miles. The fire department requires all new fire fighters to complete fire fighter level I and fire fighter level II requirements, Emergency Medical Technician courses, hazmat, driver and vehicle operations, first aid, search and rescue, live fire training, and cardiopulmonary resuscitation (CPR). Fire fighters are then assigned to a department where they are

placed on probation for 1 year. Each fire fighter is also certified as an Emergency Medical Technician (EMT). Refresher training courses are continued throughout the year. The victims' training records were reviewed and appeared to be adequate. Victim #1 had 6½ years of experience as a fire fighter and EMT, while Victim #2 had 3½ years of experience as a fire fighter and EMT.

Additional companies responded to this incident; however, only those directly involved are included in this report.

INVESTIGATION

On May 30, 1999, at 0017 hours, Central Dispatch received a call of a house fire. Dispatch toned out a box alarm which consisted of the following:

- 1st due Engine 26 (Lieutenant and 3 fire fighters [including Victim #1])
- 2nd due Engine 17 (Captain and 3 fire fighters)
- 3rd due Engine 10 (Lieutenant and 3 fire fighters [including Victim #2])
- 4th due Engine 12 (Lieutenant and 3 fire fighters)
- 1st due Truck 15 (Captain and 3 fire fighters)
- 2nd due Truck 4 (Lieutenant and 3 fire fighters)
- Rescue 1 (Lieutenant and 4 fire fighters)
- Battalion Chief 1 (the Incident Commander) (BC-1)

The working fire alarm was dispatched at 0023 hours and consisted of the following:

- Engine 14 (Sergeant and 3 fire fighters)
- Chief 2
- Air 2 (1 fire fighter)
- Fire Investigation Unit (Car 43) (fire investigator)
- Alcohol Tobacco and Firearms (ATF) (Car 83)
- Medic 17 (2 paramedics)
- Department Safety Officer

The Hazmat Unit was also dispatched at the same time as the working fire alarm.

At 0029 hours, a task force alarm was toned with the following response:

- Engine 6 (Lieutenant and 3 fire fighters)
- Engine 4 (Lieutenant and 3 fire fighters)
- Truck 7 (Lieutenant and 3 fire fighters)
- Battalion Chief 4

As companies responded to the call of a house fire, dispatch made a second report that the fire was in the basement. During the investigation, it became clear that all companies did not receive the second report of a basement fire. Engine 26 was first to arrive on the scene at 0023 hours and reported smoke showing from the front of the building. Being the first-due engine, they positioned the engine in the small parking area in front of the row of townhouses (see Diagram 1). Engine 10 arrived behind Engine 26 as the third-due engine company and stretched a 400-foot, 1½-inch line to the front entrance (see Photo 1). Engine 17 was the second-due engine company, also arriving at 0023 hours. Upon arrival, Engine 17 stretched a 350-foot, 1½ -inch line around the adjacent units (see Diagram 1) to the rear of the burning townhouse. Arriving at 0024 hours was Engine 12, as the fourth-due engine company, which by department Standard Operating Procedures (SOPs), required them to back up Engine 17 in the rear. Instead of backing up Engine 17, the crew of Engine 12 went to the front. The IC (BC-1) was en route to the scene, and from the report he received from Engine 26, he requested a working-fire dispatch. The working-fire alarm dispatched Engine 14, Battalion Chief 2 (BC-2), Air 2, Fire Investigation Unit (Car 43), the Alcohol Tobacco and Firearms (ATF) unit (Car 83), Medic 17, and the department's Safety Officer. The Hazmat Unit was also dispatched at the same time. The IC ordered BC-2 to take command of the rear when he arrived on the scene.

The front door of the townhouse was open and emitting thick, black smoke. With a charged line, a fire fighter from Engine 26 (Victim #1) approached the front door, as his layout man and officer donned their SCBAs. Preparing to enter, Victim #1 experienced a problem with his SCBA face piece. He returned to the engine and switched face pieces with his Wagon Driver. After switching face pieces, he told his officer at the front door that everything was working properly and he was taking in a line. With a charged line, he entered through the front door. Shortly after, the layout man entered, followed the line, and met the fire fighter (Victim #1). The officer of Engine 26 entered last and proceeded into the structure to locate his crew. With a charged line, a fire fighter (Victim #2) and the Lieutenant from Engine 10 entered behind the officer from Engine 26 to provide back up. The layout man from Engine 10 was ordered by his Lieutenant to stay at the front door and feed the line inside.

Truck 15 arrived on scene at 0024 hours as the first-due truck company, and started ventilation in the front according to department SOP requirements. The officer and a fire fighter on Truck 15 threw a ladder to the roof and the officer began to ventilate the large front window at ground level. Security bars were blocking the window, so a fire fighter from Truck 15 entered the structure, approximately 10 feet into the kitchen area, to vent

the window from the interior. The fire fighter then exited the structure (see Floor Plan A-1). Next, the officer from Truck 15 climbed the ladder and stopped at a window on the second floor to knock it out. After knocking out the window, he returned to the ground as the driver and Tiller man from Truck 15 climbed the ladder to the roof. The two of them cut approximately three vent holes in the roof and stated that thick, black smoke was emitting from the holes. Truck 4 arrived at 0025 hours as the second-due truck company and began ventilation in the rear of the structure. *[NOTE: Truck 4 was responding for Truck 13, which was out of service at the time of this incident. Truck 13 was housed in the same station as Engine 10 and would have arrived on the scene at the same time as Engine 10 (approximately 2 minutes earlier) if it had been in service.]* On arrival, a fire fighter and the officer from Truck 4 began forcible entry to the rear basement sliding-glass door (which was protected by an iron security gate (see photo 2)) as the driver and the Tiller man from Truck 4 threw ladders to the windows above the door (see Floor Plan A-2). The fire fighters stated that they saw small spot fires all over the basement floor. The driver and the Tiller man tried to knock out the windows on the second floor, but felt they were unsuccessful because they could not feel the ladders breaking the glass. They also tried to break the sliding-glass door on the first floor with the ladder, but could not. *[NOTE: The windows on the second floor were left open by the homeowner, which is why the fire fighters could not feel the glass break. The sliding-glass door on the first floor was a two-panel sliding-glass door, which fire fighters could not break with the ladder they were using. The sliding-glass door on the first floor had no security gate over it.]* The driver and Tiller man from Truck 4 left the ladder at the window on the second floor and returned to the truck to get a second ladder to go to the roof.

Engine 17 was now positioned at the rear sliding-glass door as Truck 4 prepared entry (basement level). Using a gas-powered saw and a sledge hammer, the officer and fire fighter from Truck 4 removed the iron security gate and broke open the glass door at 0026 hours (see Photo 2). Members of Truck 4 and Engine 17 stated that when the sliding-glass door was opened, air began to be sucked inside by the fire. They also saw small fires on the floor and stated that when the door was opened the fires grew larger. The Lieutenant from Engine 17 reported to the IC that they had fire on the first floor and requested permission to hit the fire. *[NOTE: Engine 17 was unaware that they were at the basement level due to the route they took to get to the rear. As they proceeded to the rear, they noticed the row houses they went between were only two stories, which caused confusion (see Diagram 1).]* The IC denied their request in fear of opposing hose lines. He then radioed the officer from Engine 26 to locate their position. He received no response from them. The IC knew that the crews from Engine 26 and Engine 10 had entered through the front door on the first floor.

Rescue 1 arrived on the scene at approximately the same time that Truck 4 made entry. They were required to complete search and rescue operations. Two fire fighters from Rescue 1 and a fire fighter from Truck 4 entered the basement to search the interior for any civilians. Shortly after they entered, the Lieutenant from Engine 17 ordered them out as conditions began to deteriorate. One of the fire fighters who exited stated that they were able to follow a small path (limited fire) to the exterior before the entire basement erupted into flames.

The driver and Tiller man from Truck 4, who returned to the truck to retrieve a second ladder, saw that the basement was fully engulfed with fire. They decided to pull a line from Engine 12 to provide back up for Engine 17. Engine 12 was supplying Engine 17 and had positioned their engine towards the rear of the structure, but Engine 12's crew proceeded to the front of the structure (see Diagram 1). The officer and a fire fighter from Engine 12 entered the front of the structure advancing approximately 2 to 3 feet, where they remained throughout the attack. The Lieutenant from Engine 17 requested to hit the fire a second time and was denied. The IC denied their request because he still had not received a response from the officer of Engine 26. The IC radioed the officer of Engine 26 a second time and received no response.

At this point Engine 26 and Engine 10 were inside the structure searching for the basement door. Department SOPs required them to locate the basement door and close it or hold off at the stairs with a fog spray. The fire fighter on Engine 26, who entered the structure to back up the Nozzle man (Victim #1) stated that it was extremely hot, but tolerable, when he met up with Victim #1. He stated that the floor was solid and as they proceeded further into the structure, and visibility was improving. He recalled seeing the sliding-glass door to the rear of the first floor, a table, and a sofa on his right side. This would position Victim #1 and the fire fighter in the living room, in front of the basement-stairs door (see Floor Plan A-1). He also stated there were no signs of fire and the heat remained constant. He could not recall his officer joining the two fire fighters, but did recall hearing a radio transmission. *[NOTE: Only officers carry radios and he did not know whose radio he heard.]* It was determined that Engine 10 was inside backing them up at this time, however, the two fire fighters from Engine 26 were unaware of any other fire fighters inside.

After hearing the radio transmission, the fire fighter from Engine 26, backing up Victim #1, looked over his left shoulder and saw fire appear, filling up what looked to be a doorway. He stated the fire came out of the doorway, then disappeared, and everything went black. At that point he felt an intense blast of heat. He dropped the line and immediately started squirming around in his turnouts, in an attempt to release the heat. He asked Victim #1 where the hose line was and related to him that something was wrong and they had to get out. Victim #1 responded by saying that he did not know where the hose line was. The fire fighter stated that Victim #1 sounded as if he was in a crouched position waiting to be rescued. He then heard a loud scream from his left side, which lasted approximately 15 seconds. The scream was clear and not muffled by an SCBA. He stated that the scream was getting closer when he heard a loud thump, as if someone dropped to the floor, and then complete silence. He then crawled forward and found the nozzle of a hose line. *[NOTE: Victim #2 was found not wearing his SCBA face piece. It is believed the scream was from Victim #2.]*

The Lieutenant on Engine 10 recalled that as they backed up Engine 26, he turned back towards the front door and could see some light from the front doorway (entrance). He also stated that it was very hot inside the structure. As he turned back around, he felt an intense blast of heat and was knocked backward by a frantic fire fighter attempting to exit. The lieutenant then exited through the front door. When the heat hit the fire fighters, the Lieutenant thought that he was in the hallway, next to the basement door (see Floor

Plan A-1). The officer of Engine 26 stated that as he made his way toward the rear of the structure to join his crew, he also encountered an intense blast of heat. Feeling that he was being burned, he quickly turned, and exited through the front door. The layout man from Engine 10 started pulling out the hose line from Engine 10, in an attempt to assist Victim #2 in his exit. As he pulled the hose line out, he noticed there was no one on the end, which meant Victim #1, Victim #2, and the fire fighter from Engine 26 remained inside.

As the officers from Engine 26 and Engine 10 exited, the IC was walking up to the structure to get a better position. The IC was unaware of any problems until he got close enough to see the fire fighters exiting. He immediately ran to the front and saw the officer from Engine 26, who related to him that Victim #1 was still inside. The IC then saw the Lieutenant from Engine 10 and ordered him to go back inside with his crew and search for Victim #1. The IC later recalled that the Lieutenant from Engine 10 appeared to be dazed and did not relate to him that anyone else was missing. The IC only became aware that Victim #1 was missing at this time.

The fire fighter from Engine 26, who was still inside, stated that as he grabbed the nozzle he rolled on his back and opened it on the ceiling in a straight stream circular pattern. He felt the room was going to flash and wanted to cool it down. As he applied water, he recalled seeing fire on the ceiling. He stated that the water reduced the heat, but it was still very hot. He opened the line a second time on the ceiling and did not see any fire. He then followed the line, exiting the structure. He did not hear any other fire fighters inside or any Personal Alert Safety Systems (PASS) alarming at that time. He stated that he was inside for approximately 1½ minutes from the time the blast of heat hit them until his exit. He exited the structure at approximately 0031 hours. He asked if Victim #1 had made it out and was told that he had not. He communicated to the IC that he thought Victim #1 was still inside, straight back through the hall, and to the right by a sofa (see Floor Plan A-1).

The IC received an additional request from Engine 17 in the rear, this time stating they were at the basement level and had heavy fire inside the basement. Engine 17 requested permission to hit the fire and the IC responded by telling them that they had a fire fighter down inside, on the first floor, and to hit the fire with a straight stream. Engine 17 opened the straight stream on the fire in the basement and quickly knocked it down. At approximately 0032 hours, the Lieutenant from Engine 10 reentered the townhouse to begin his search.

Joining the Lieutenant was the Lieutenant and a fire fighter from Rescue 1. They entered through the front door to begin their search, stating the heat was tolerable, and visibility was improving. As they got inside the structure they could hear a PASS alarm going off. They immediately followed the shrill alarm to locate a downed fire fighter. The fire fighter was lying under a table, unconscious, and with his SCBA face piece off. His SCBA was equipped with an integrated PASS alarm, which was automatically activated when the victim turned on his SCBA. After locating the downed fire fighter, they called for assistance to remove him. The IC ordered the Hazmat crew to enter and assist removing the downed fire fighter. Engine 14's crew was already on their way inside to provide assistance. Additional fire fighters from Engine 6 and Engine 4 also entered the

townhouse and helped remove the victim to the front lawn, at approximately 0045 hours. They immediately started cardiopulmonary resuscitation (CPR) and provided medical treatment to the victim's burns. The victim, who was later identified as Victim #2, was severely burned and the IC could not determine if it was the fire fighter they were searching for, or another fire fighter. A fire fighter standing nearby related to the IC that he could tell by the size of the victim that it was not Victim #1. The IC continued the search efforts, and at approximately 0049 hours, Victim #1 was found and removed. He was found slumped over the couch face down (see Floor Plan A-1). He was found equipped with a PASS device (manually operated) attached to his turnout gear. The PASS device was not activated and was found in the off position. *[NOTE: The PASS device was later inspected and was determined to be working properly.]* Fire fighters removed the victim to the front lawn of the structure where they located a pulse and immediately provided medical treatment. All three fire fighters, along with the Lieutenant from Engine 26, were transported to a nearby hospital.

Victim #1 was treated for his burns and was admitted to the burn unit. He was pronounced dead the following day, May 31,1999, at 1450 hours. Victim #2 was pronounced dead on arrival to the hospital on May 30,1999, at 0108 hours. The injured fire fighter from Engine 26 received first-, second-, and third-degree burns to over 60 percent of his body. He was admitted to the burn unit where he was treated for his burns. He has been released from the burn unit and is currently undergoing rehabilitation. The Lieutenant from Engine 26 received treatment for burns to his hands and head area and was released the following day. He is currently back to his normal duties.

CAUSE OF DEATH

According to the Medical Examiner, Victim #1 died due to thermal injuries involving 60% of total body surface area and airways. Victim #2 died due to thermal injuries involving 90% of total body surface area and airways.

RECOMMENDATIONS AND DISCUSSION

Recommendation #1: Fire departments should ensure that the department's Standard Operating Procedures (SOPs) are followed and refresher training is provided.

Discussion: *"It is imperative that companies perform their duties as described in the Standard Operating Procedures (SOPs) unless directed by, or with notification to, and approval of, the Incident Commander."*[1] According to department SOPs, the following procedures should take place:

- ***Engines responding should take their due positions.***

Department SOPs state that the first-due engine company will layout and take a position in the front of the building. The second-due engine company should layout and take a rear position. The third-due engine company should back up the first-due engine

company in the front and the fourth-due engine company should back up the second-due engine company in the rear. Engine 12 was the fourth-due engine company, and according to department SOPs was required to back up Engine 17 in the rear. On arrival, Engine 12 proceeded to the front of the structure and took position, leaving Engine 17 in the rear with no back up. Throughout operations, Truck 4 backed up Engine 17 in the rear.

- ***Officers should keep in contact, physically or verbally, with their crews at all times during interior fire fighting.***

Department SOPs state that the officer in charge (OIC) should always be in contact with his crew by voice, touch, or sight.

- ***Ensure that when a fire fighter is not accounted for, it is reported to the IC immediately and a roll-call is ordered.***

Department SOPs state that a mechanism to quickly account for personnel must be available to the IC at any point during the incident. The officer from Engine 10 exited the structure without Victim #2. At that point, the victim's position was not accounted for, and it was not reported to the IC. When the IC becomes aware a fire fighter is not accounted for, a roll-call should then be ordered. When the roll-call is taken, any fire fighters not accounted for should be immediately reported to the IC. In this incident, the IC only became aware that Victim #1 was missing at the time search and rescue efforts took place.

- ***Provide adequate personnel to operate according to department SOPs.***

Department SOPs state that Sector Leaders can be assigned to sectors for accountability, to monitor progress, redirect activities within the sector, coordinate activities, monitor safety, request additional resources as needed, communicate with command or other Sector Leaders, and reallocate resources within the sector. The Sector Leader would be a company officer or a Battalion Chief and would be designated as Sector Leader by the IC. In the early stages of this incident, an adequate number of personnel were not on the scene to perform effectively and in accordance with the department SOPs. The officer on Truck 4 was performing tasks with one of his fire fighters while the officer on Engine 17 was on the initial attack line in the rear. All ventilation efforts in the rear were not completed when conditions rapidly changed (the sliding-glass door on the first floor was not vented until conditions deteriorated). Truck 4 eventually backed up Engine 17, because Engine 12 had proceeded to the front of the structure, which also delayed ventilation. With all officers in the rear performing operational tasks, no monitoring took place. This hindered the opportunity to complete proper ventilation, to provide timely reports to the IC, and allowed a breakdown in communication. To be compliant with department SOPs, additional personnel would have been needed to free up a company officer to serve as a Sector Leader.

- ***Ensure that first arriving companies give the required size-up report to communications on the fire ground channel.***

According to department SOPs, the first arriving units in the front and rear of the building, or the incident site, should give a size-up report to communications on the fire channel 1 and then switch to the fire ground channel for subsequent fire ground communications. The fire ground channel is an informal radio channel to report what you see, what you

don't see, and what you think. It is to be used for fire ground communications between units, between units and Sector leaders, and between Sector Leaders and the Incident Commander. All responding units will monitor the fire ground channel to hear reports between units on scene and the responding Battalion Chief, and will be aware of the fire ground situation before arrival. Also, responding units should monitor the fire ground channel since they may be contacted by the Battalion Chief or Sector Leader for assignment prior to arrival on the fire ground. In this incident, Engine 26 gave a size-up report to communications when they arrived. A size-up of the rear conditions was never reported by the first arriving unit in the rear.

Fire departments should also ensure that, whenever possible, a size-up is made from the inside. At the initial stage of a fire the inside size-up is more accurate and useful than the size-up made from outside the building. The officers inside the structure are closer to the fire and obviously can see more than someone outside the building at the command post.[2]

Recommendation #2: Fire departments should consider providing the Incident Commander with a Command Aide.[3-5]

Discussion: Aides are personnel assigned to assist the Incident Commander. During large operations, Sector Leaders also may have aides to assist them. They do this by managing information and communications. They can keep track of assignments, locations, and the progress of companies, assist with tactical worksheets, or access reference materials and pre-fire plans. Another important function they may perform is to provide reconnaissance and operational details for the IC (his eyes and ears). Some jurisdictions assign full-time aides to command officers to perform routine administration functions and to act as drivers in addition to their fire ground role. Departments should consider the aide to be an individual that has the experience and authority to conduct the required tasks.

Battalion Fire Chiefs are required to respond quickly to emergency incidents. In their response, they have to be fully aware of heavy traffic conditions, construction detours, traffic signals, and other conditions. Also, they must monitor and comprehend which companies are responding, fire ground activity, fire conditions, and additional information from dispatch. If possible, they will also monitor all incoming information from dispatch and the fire ground and make important decisions. Aides could assist the Battalion Fire Chief in processing information without distraction and complete the necessary tasks en route to the scene. In this incident, an aide could have been directed to go to the rear of the structure and determine what floor level the fire fighters in the rear were on. The aide could have also driven the IC to the incident scene, freeing up the IC to better comprehend all information and make important decisions prior to arrival.

Recommendation #3: Fire departments should ensure that fire fighters from the ventilation crew and the attack crew coordinate their efforts.

Discussion: The importance of ventilation when attacking basement fires cannot be overemphasized. Fire can quickly spread upward into the structure causing potential problems such as a flashover, back draft, or weakening of the structure. Ventilation timing is extremely important and must be carefully coordinated with both fire attack and ventilation crews. Ideally, it should occur just ahead of interior crews advancing their hose lines. Properly ventilating the heat and smoke from buildings can reduce the possibilities of potentially hazardous situations fire fighters can be faced with. The fire fighters performing ventilation tasks should be in communication with the fire fighters attacking the fire or entering the structure to coordinate their efforts. In this incident, fire fighters from Engine 26 entered the structure as fire fighters from Truck 15 began ventilation efforts in the front of the structure. Truck 4 was delayed in its ventilation efforts because it arrived late as a replacement for Truck 13 (which was out of service). The crew from Engine 10 also entered behind Engine 26 as back up. At that point, ventilation had not been completed. Fire fighters on the attack lines experienced considerable heat and heavy smoke conditions. They were forced to crawl inside the structure and stated that the heat remained consistent as they proceeded into the structure. When the rear sliding-glass door (basement) was opened by Truck 4, the small fires in the basement began to grow rapidly.

Recommendation #4: Fire departments should ensure that when a piece of equipment is taken out of service, appropriate backup equipment is identified and readily available.

Discussion: Equipment on the fire ground is very important to any fire ground operation. It should be kept clean, in safe operating condition, and repaired when necessary. When any piece of equipment is taken out of service for repair, a new or backup piece of equipment should be immediately placed in service. In this incident, the truck company (Truck 13) that would have responded with Engine 10 was out of service. A backup truck was not placed in service to replace Truck 13 causing Truck 4 to be dispatched from a different location. Truck 4 arrived on the scene approximately 2 minutes after Engine 10 (Truck 13 would have arrived on scene approximately the same time as Engine 10), which delayed ventilation procedures.

Recommendation #5: Fire departments should ensure that personnel equipped with a radio position the radio to receive and respond to radio transmissions.

Discussion: The fire ground communications process combines electronic communication equipment, a set of Standard Operating Procedures, and the fire personnel who will use the equipment. To be effective, the communications network must integrate the equipment and procedures with the dynamic situation at the incident site, especially in terms of the human factors affecting its use. The ease of use and operation

may well determine how consistently fire fighters monitor and report over the radio while fighting fires. In this incident, radio calls were made several times by the IC to an engine company, and the IC never received a response. Dispatch tapes recorded the transmission made by the IC to the engine company, but it remains unclear why the engine company never responded. NIOSH investigators have also reviewed a photograph taken approximately the same time the interior crews had exited the structure. An officer in the photograph had his radio positioned in his front bottom pocket (approximately waist level) of his turnout coat. The officer was not identified. Fire departments should review both operating procedures and human factors issues to determine the ease of use of radio equipment on the fire ground to ensure that fire fighters consistently monitor radio transmissions from the IC and respond to radio calls.

Recommendation #6: Fire departments should consider using a radio communication system that is equipped with an emergency signal button, is reliable, and does not produce interference.

Discussion: Radio communication is one of the most important functions on the fire ground. When situations on the fire ground arise, radio transmissions need to be made in a timely and understandable fashion.

- ***Departments should operate on a radio frequency that does not "bleed over" or cause interference.***

Radios need to be reliable, in good working condition, and fully charged and ready to use. They should not produce interference or "*bleed over.*" Fire departments should also take into consideration the frequency on which the radio communications system will operate. The National Fire Protection Association (NFPA) recommends that frequencies should be 15 kHz apart in the VHF high band. The separation in frequencies is to avoid possible interference. The frequencies used by the department involved in the incident are 15 kHz apart. However, in the past, this department has experienced problems with interference or "bleed over" between Channels 1 and 4. Interference or "bleed over" between Channel 1 and Channel 4 has been noted because the frequencies are close to one another. The frequency for Channel 1 (Fire Channel) is 154.190 KHz and the frequency for Channel 4 (Fire ground Channel) is 154.205 KHz. Although the frequencies meet the NFPA recommended standard of separation, there still remains a problem with "bleed over" or interference. For this reason, departments should consider changing the fire ground channels or adjust the frequencies to reduce further "bleed over" or interference. The radio of the officer from Engine 26 was tested after the fire and appeared to be working properly. The officer could not recall receiving any radio transmissions from the IC; however, the dispatch tapes recorded a radio transmission from the IC to the officer of Engine 26. There is a possibility that the officer did not receive the call because of "bleed over" or interference.

- ***Departments should consider using portable radios equipped with an emergency signal button.***

Fire fighters are always encountering potentially hazardous situations and should be prepared with the proper equipment to assist them in an emergency. Departments should consider using portable radios equipped with an emergency signal button. When fire fighters become trapped or encounter an emergency situation where assistance is needed, they could push the emergency signal button on their portable radio. When the emergency signal button is pushed, it would transmit an emergency alert signal to dispatch, the IC, or possibly all radios. This signal would signify that a fire fighter needs assistance and would alert all fire ground personnel that an emergency call is going to be transmitted.

Recommendation #7 Fire departments should ensure that all companies responding are aware of any follow-up reports from dispatch.

Discussion: From the very beginning of fire ground operations, the IC must use communications to initiate and evaluate fire ground actions. Upon arriving, he needs to advise all operating companies of the basic details of the attack plan and provide an initial status report. This transmission should explain the conditions he can see from the command post, and should be directed to everyone on scene, arriving at the scene, or en route to the scene. The initial report should provide a standard description of the following items: building size, building height, occupancy, fire/smoke conditions, confirmation of any additional reports, designation of command, and action being taken. If a Sector Leader is assigned, the IC can communicate directly to the Sector Leader to receive direct transmissions. Additional reports initiated by dispatch should be noted and all companies, on the scene or responding, should be aware of the report. In this incident, the initial dispatch report stated that it was a house fire. As companies responded, dispatch made a second report stating the fire was in the basement. Some of the companies acknowledged the report, others did not. Fire departments should develop and implement a SOP to ensure all radio transmissions are received by all responding units.

Recommendation #8: Fire departments should ensure that a Rapid Intervention Team is established and in position immediately upon arrival.

Discussion: A Rapid Intervention Team (RIT) should respond to every major fire. The team should report to the officer in command and remain at the command post until an intervention is required to rescue a fire fighter(s). The RIT should have all tools necessary to complete the job, e.g., a search rope, first aid kit, and a resuscitator to use if a fire fighter becomes injured. The RIT will be ordered by the IC to complete any emergency searches or rescues. It will provide the companies with the opportunity to regroup and take a roll call, instead of performing rescue operations. When the RIT enters to search and rescue, each team member will have a SCBA with a full cylinder and will be physically prepared. In this incident, the officer on Engine 10 and fire fighters

from additional companies, who had already been involved in fire ground operations, entered the structure to search for Victim #1. If a roll call had been ordered during search operations, the officer of Engine 10 would have been inside the structure and would not have been able to report to the IC that one of his crew members was unaccounted for. If a RIT had been in place, accountability calls could have been conducted because fire ground officers would not have been directed to rescue operations.

Recommendation #9: Fire departments should ensure that any hose line taken into the structure remains inside until all crews have exited.

Discussion: Fire fighters who enter smoke-filled enclosures should be equipped with a safety line or hose line in the event that a fire fighter becomes disoriented or trapped. Many fire fighters who die from smoke inhalation, a flashover, or are caught or trapped by fire, actually become disoriented first. They are lost in smoke, their SCBA run out of air, or they cannot find their way to exit through the smoke. Although fire or smoke kills them, the primary contributing factor is disorientation. By using a life line or hose line, the fire fighter is able to determine the direction of exit by the couplings that connect two hose lines together. The male coupling signifies the exit direction. When trying to exit, fire fighters are trained to find the line and follow it out, which is what the injured fire fighter from Engine 26 did. The line should remain inside as a guide for fire fighters to follow.

Recommendation #10: Fire departments should consider providing all fire fighters with a Personal Alert Safety System (PASS) integrated into their Self-Contained Breathing Apparatus.

Discussion: PASS devices, which are electronic devices worn by the fire fighter, emit a loud and distinctive alarm if the fire fighter becomes motionless for more than 30 seconds. Fire fighters entering hazardous areas should be equipped with PASS devices. There are several types of PASS devices available. One device that could be used is the PASS that is integrated into the SCBA. PASS devices integrated into the SCBA will be activated when the SCBA air cylinder is turned on. Manual PASS devices are also used throughout the fire service. These devices require the fire fighter to manually turn on the device each time they use it. In this incident, Victim #2 was equipped with a PASS device integrated into his SCBA. Victim #1 was equipped with a manual device. When search efforts took place, the fire fighters searching the structure were only aware that Victim #1 was missing. When they entered the structure, they recalled hearing a PASS device sounding. The fire fighters followed the alarm and located a fire fighter, later to be identified as Victim #2. Victim #1 was located inside the structure approximately 4 minutes later. Victim #1 was found to be equipped with a manual PASS device attached to his turnouts. However, his PASS device was never turned on.

Recommendation #11: Fire departments should develop and implement a preventive maintenance program to ensure that all SCBA's are adequately maintained.

Discussion. Fire departments should establish service and maintenance procedures and rigidly enforce them to provide respirators that are dependable and are constantly evaluated, tested, and maintained. Equally important is record keeping, a critical element of any respirator maintenance program. During this incident, Victim #1 stated that as he prepared to enter the structure, he experienced a problem with his SCBA face piece. He returned to the engine and replaced his face piece with the Wagon driver's face piece. NIOSH completed an evaluation of the fire department's SCBA program on July 21, 1999 and issued a report to the department (see Attachment 1).

Photo 1: *This photo depicts the front (side 1) entrance of the townhouse involved in the incident.*

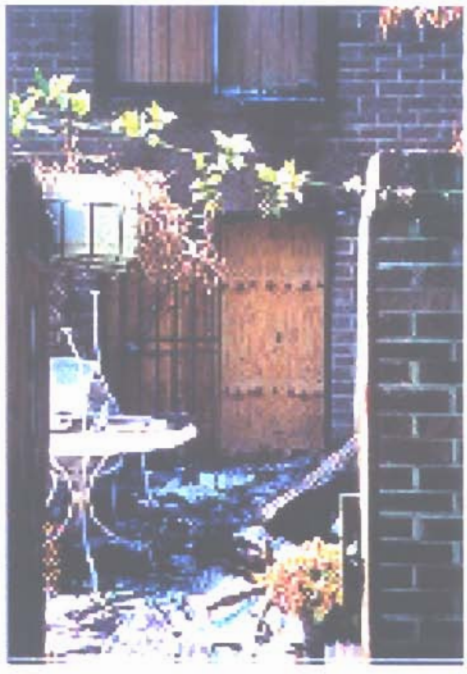


Photo 2: *This photo depicts the rear (side 3) sliding-glass door leading to the basement*

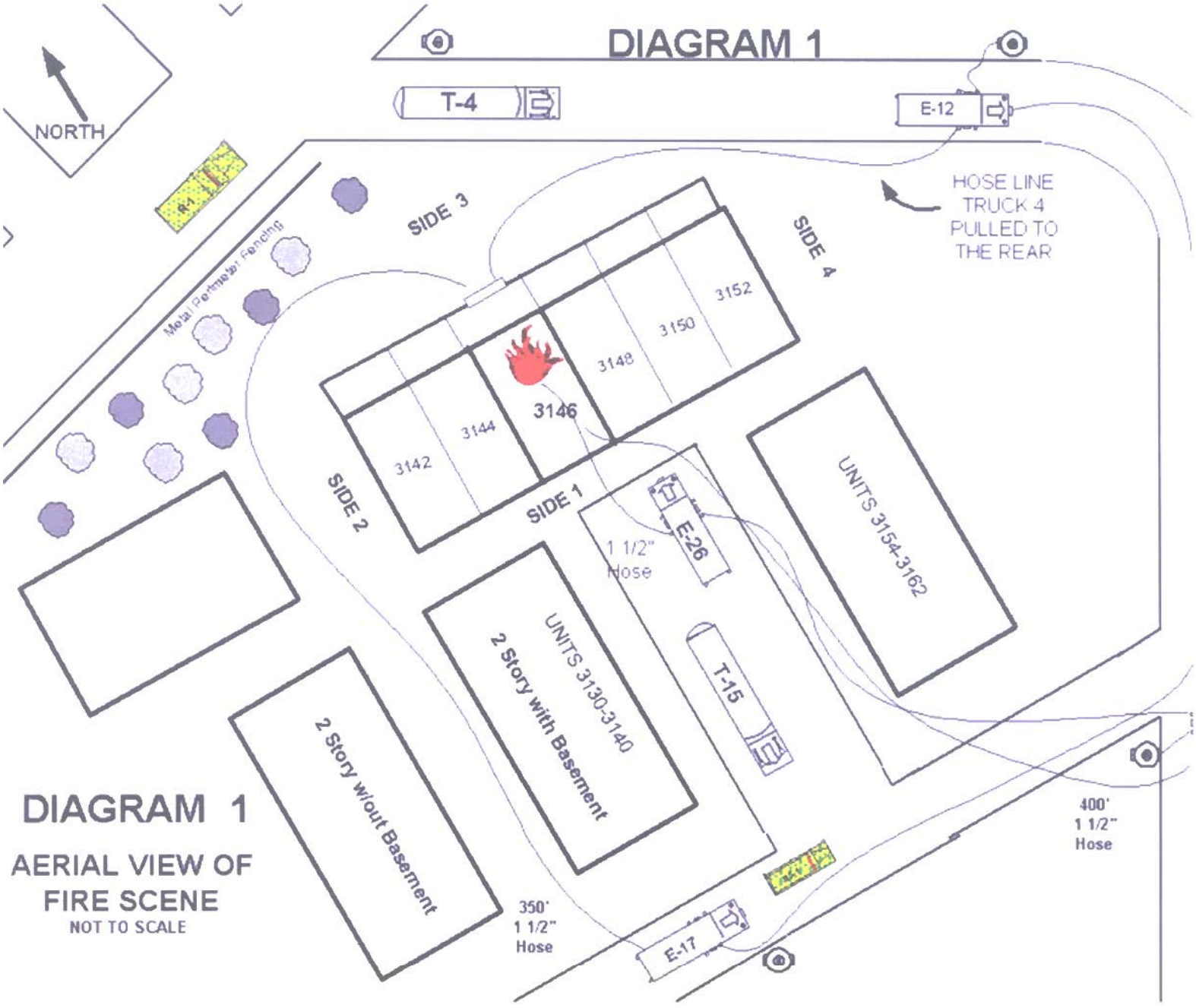


DIAGRAM 1

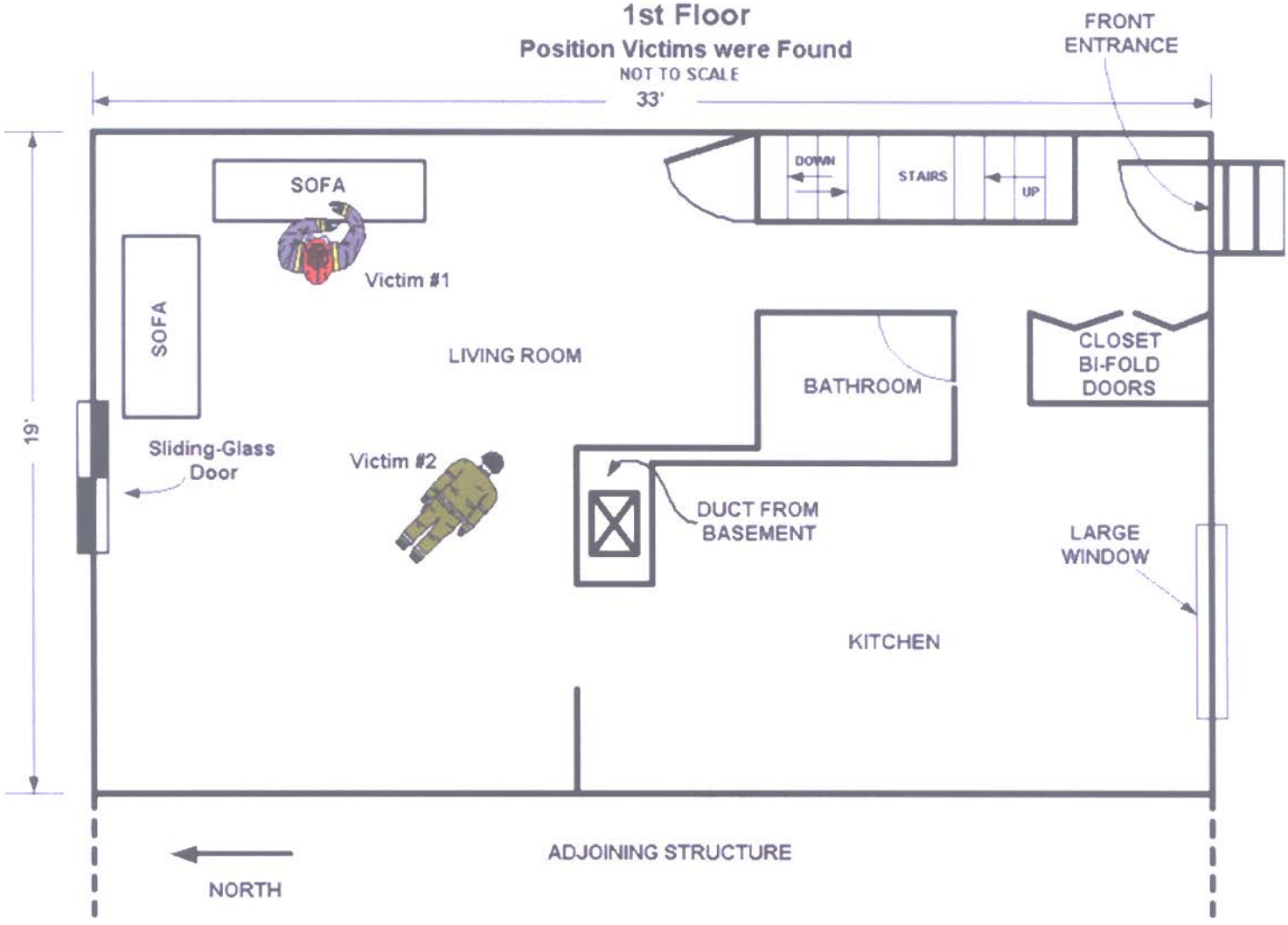
AERIAL VIEW OF FIRE SCENE

NOT TO SCALE

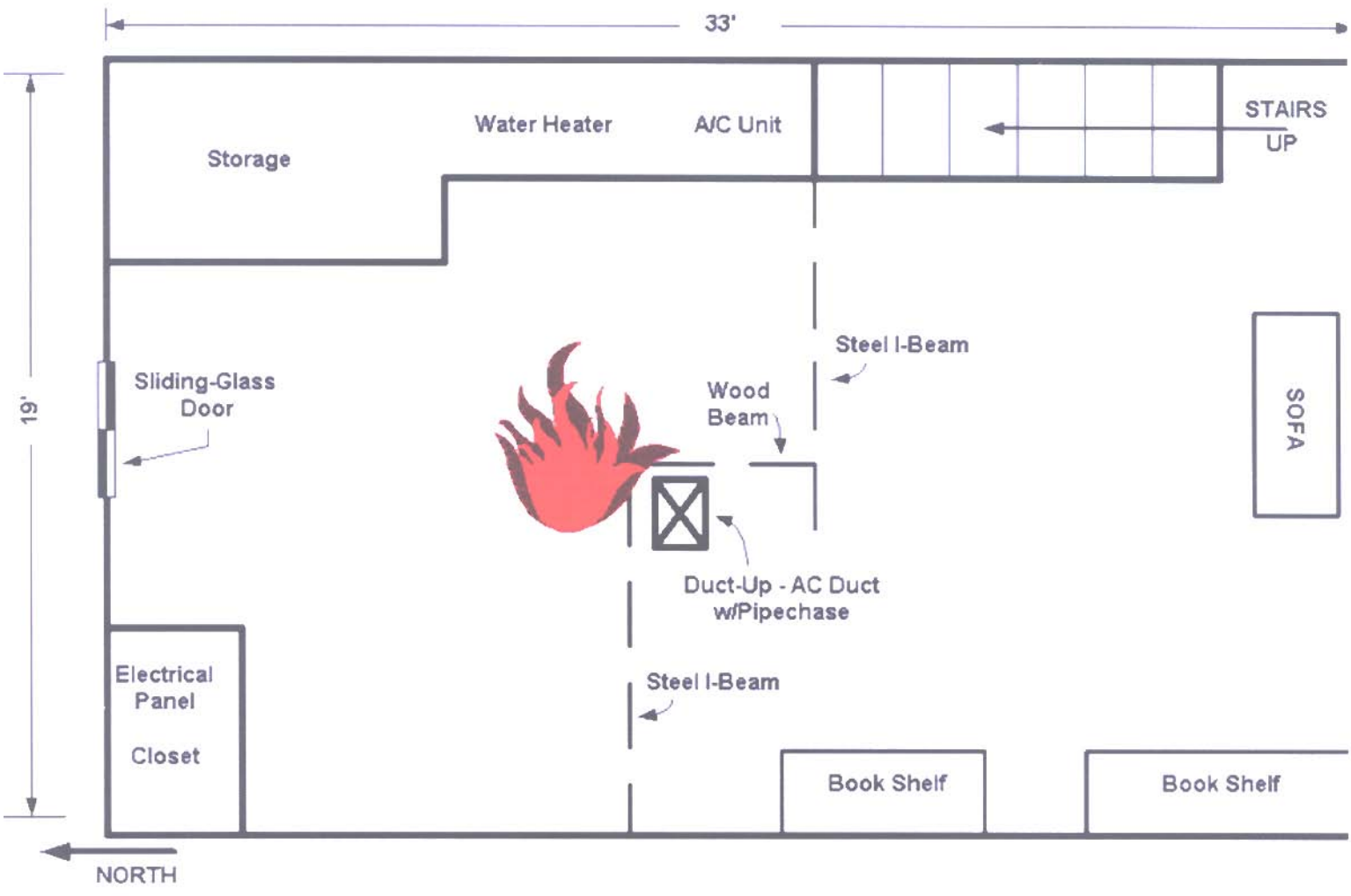
Floor Plan A-1

1st Floor

Position Victims were Found



Floor Plan A-2
Basement
NOT TO SCALE



Floor Collapse in a Single Family Dwelling Fire Claims the Life of One Fire Fighter and Injures another - Kentucky

SUMMARY

On February 17, 1997, two male fire fighters (the victim and injured) were part of a fire company that responded to a single family dwelling fire. When the fire company arrived at the fire scene, the District Major reported heavy smoke emitting from the roof area of the dwelling. The victim and injured pulled two water hoses from the engine they were assigned to and proceeded toward the dwelling. After knocking down a ceiling fire, they entered the dwelling through the front door and both immediately fell through the floor into the basement area. One fire fighter was seriously injured while the victim died from asphyxiation. NIOSH investigators concluded that, to prevent similar occurrences, employers should:

ensure that fire command always maintains close accountability for all personnel at the fire scene

ensure at least four fire fighters be on the scene before initiating interior fire fighting operations at a working structural fire

ensure that fire fighters who enter hazardous areas, e.g., burning or suspected unsafe structures, be equipped with two-way communications with incident command.

INTRODUCTION

On February 17, 1997, two male fire fighters (the victim and injured), ages 29- and 31-years-old, respectively, entered a single family dwelling that had heavy smoke emitting from the roof area and from around the door and window openings. The two fire fighters entered the house through the front door and both immediately fell through the floor into the basement area. One fire fighter was seriously injured while the victim died from asphyxiation. On March 10, 1997, the International Association of Fire Fighters (IAFF) requested that NIOSH provide technical assistance in reviewing the circumstances surrounding the fatality and serious injury. On April 15, 1997, the Chief of Trauma Investigations Section and a Safety Specialist traveled to Kentucky to conduct an investigation of this incident. Meetings were conducted with Kentucky OSHA personnel, including the OSHA compliance officer assigned to the case, fire department officers, the IAFF union representative, and the State Fire Marshall. Copies of photographs of the incident site and the transcription of dispatch tapes were obtained, and a site visit was conducted.

The fire department involved in the incident serves a population of 240,000 in a geographic area of 280 square miles. The fire department is comprised of approximately 430 employees, of whom 360 are fire fighters. The fire department provides all new fire fighters with the basic 16-week recruit training at the fire department training center. The department also requires 100 hours of additional on-the-job training for each fire fighter each year. The required training is designed to cover fire department operation, e.g., ladder training, aerial operations, hose training, breathing apparatus, etc. Recertification training is conducted at the training center on an annual basis. The fire department's written standard operating procedures manual was reviewed and appears to be complete. The victim and injured had 7 and 4 years fire fighting experience respectively.

The site of the incident, a one-story single family residence measuring 28 feet by 28 feet, was located in a residential neighborhood. Most of the homes in the area were one-story frame and vinyl/aluminum sided structures and mobile homes, with the exception of the residence involved in the incident. The roof had been constructed of wood framing and sheeting, and shingles, while the exterior walls of the residence had been constructed of concrete block. The residence had a full basement about 8 ½-feet high; access to the basement was gained through either an interior stairway or an exterior doorway which was located on the back side of the residence.

Although two fire companies were involved in this incident, only those directly involved up to the time of the fatal incident are mentioned in this report. The figure shows all companies responding to this incident.

INVESTIGATION

On February 17, 1997, at 0009 hours, a fire call came into the 911 dispatcher from the occupant of a private residence adjacent to the incident site. The call was immediately directed to the fire station serving the district of the city where the fire was located. The District Major-204, Engine-11, Engine-6, Emergency Medical Service-EC6, and Aerial-4 were ordered to respond. Altogether, 5 pieces of equipment and 16 personnel arrived at the fire scene between 0013 and 0014 hours. The District Major was first on the scene at 0013 hours and assumed command. All the remaining vehicles and crews arrived seconds behind the District Major.

When the District Major pulled up near the front of the residence where the incident occurred, he reported heavy smoke coming from the structure. He then asked a small group of spectators standing on the street, whether anyone might be in the house. A spectator responded that they didn't think anyone lived there. He then ordered fire fighters from Engine II to pull two 1 3/4-inch water lines and approach the front door area. After the lines had been pulled and moved to the door area, it was discovered that the pressure relief valve on the Engine 11 water pump was sticking and could not sustain adequate water pressure. In the interim, a fire fighter attempted to open the front door, but found it was locked. He kicked open the door which allowed considerable amounts of heavy black smoke and heat to emit from the door opening. He was ordered to close the door and pull two lines from Engine 6. Also, fire fighters from Aerial 4 had started a

generator and illuminated the area, then carried two positive pressure ventilation (PPV) fans to the front of the residence. The PPV fans were started, but use of the fans was restricted until charged lines were brought to the front door area. Other fire fighters had pulled exposure lines and were fighting fires on the opposite side of the structure and protecting an adjacent residence.

While the District Major was working with the engineer from Engine 11, trying to get the pump on Engine 11 functioning, he called for Engine 6 to pull two water lines. Two fire fighters (the victim and injured) pulled two lines from Engine 6 and proceeded to the front door of the residence. The air-flow volume of the PPV fans was increased and aimed toward the door opening. The two fire fighters from Engine 6 donned their self-contained breathing apparatus (SCBAs) and knocked down some fire in the ceiling area of the structure before making entry (unknown to the fire fighters, that three separate fires were burning in the basement--one fire was directly below the entry of the front door). Shortly thereafter (about 2/3 minutes after donning their SCBAs) the two fire fighters entered the house through the front door to attack the interior fire, and immediately fell through the floor into the basement area. Approximately 8 minutes had elapsed and the District Major said "let's ease off this thing for a minute," (pull back and regroup), and then realized two fire fighters were missing. A lieutenant, after being advised of the problem, crawled along the ground and discovered hose lines going into the front doorway and down into a hole. A light from a flashlight was seen in the smoke/darkness of the hole and the lieutenant stuck his right hand into the floor opening and was grabbed by the one of the fire fighters (injured). At about the same time, fire fighters on the outside of the house lowered a 14 foot ladder through the front doorway into the basement; the ladder brushed up against the injured fire fighter and he grabbed it. The injured was pulled/lifted from the basement area with the aid of the ladder. The injured fire fighter, after being extracted from the basement, advised others that the other fire fighter was still in the basement. Numerous search and rescue efforts were made through the hole in the floor and from the back door to the basement. The victim was eventually located and removed from the basement area, and vital signs were checked at 0118 hours, approximately 53 minutes after the victim and injured were discovered missing. The injured fire fighter reported that both he and the victim sprayed water on one another trying to stay cool. It was also reported that the injured fire fighter had manually activated his personal alert safety system (PASS) device. However, due to the noise of the engines, pumps, PPV fans, etc., no one heard the alarm. Approximately 8 to 10 minutes after entering the structure, both fire fighter's SCBAs ran out of air and they tried to breath entrained air from the water spray from their lines.

The following time line has been developed from fire and EMS dispatch sheets, and personal and taped interviews of fire personnel:

February 17, 1997 (minutes have been rounded off to the full minute)

0009 Call received at fire station

0013 District Major-204 arrives at fire scene

0014	Engine-11, Engine-6, EMS-EC-6, and Aerial-4 arrive at the fire scene
0015-0017	Victim and injured pull two lines from Engine-6, move to front door area and put on SCBAs, and fight ceiling fire
0017	Victim and injured fall into basement area
0025	Victim and injured discovered missing
0040	EC-6 departs fire scene with injured
0118	EC-5 departs fire scene with victim

CAUSE OF DEATH

Preliminary cause of death was listed by the medical examiner as asphyxiation due to smoke inhalation.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Fire departments should ensure that fire command always maintains close accountability for all personnel at the fire scene.

Discussion: Accountability for all fire fighters at a fire scene is paramount, and one of the fire command's most important duties. The District Major was directing his attention towards the various aspects of the total operation and had ordered the two fire fighters to enter the structure, but not advance too far; however, he was not aware of exactly when the fire fighters entered the structure.

Recommendation #2: Fire departments should ensure at least four fire fighters be on the scene before initiating interior fire fighting operations at a working structural fire.

Discussion: When the District Major arrived at the scene he took command and directed the operations. Personnel from the Engines and Aerial Truck were performing duties as directed, or as standard operating procedures directed. Although there were approximately 16 fire fighters on the scene, no one actually witnessed the two fire fighters (victim and injured) enter the burning structure or fall through the floor, and about 8 minutes elapsed before they were discovered missing. The National Fire Protection Association (NFPA) and the Occupational Safety and Health Administration (OSHA) recommends that four persons (two in and two out), each with protective clothing and respiratory protection, are the minimum number essential for the safety of those performing work inside a structure. The team members should be in communication with each other through visual, audible, or electronic means to coordinate all activities, and determine if emergency rescue is needed.

Recommendation #3: Fire departments should ensure that fire fighters who enter hazardous areas, e.g., burning or suspected unsafe structures, be equipped with two-way communications with incident command.

Discussion: When the two fire fighters entered the burning residence and fell through the floor, the noise from the fire fighting operations (pumps, engines, PPV fans, etc) obscured the calls for help and the audible signal from the PASS device. If the fire fighters had a portable radio, then incident command may have been able to determine that the two fire fighters were trapped in the basement of the burning structure.

Basement Fire Claims the Life of Volunteer Fire Fighter - Massachusetts

SUMMARY

On November 29, 2003, a 31-year-old male volunteer fire fighter (the victim) died while fighting a basement fire in a residential structure. The victim and another fire fighter were in the basement applying water to the fire on the ceiling. A Deputy Chief in the basement reported to Incident Command that the fire was knocked down and requested ventilation. A positive pressure ventilation fan (PPV) was started at the front door as the basement windows were vented. Suddenly, thick black smoke filled the entire basement area as the hose line became covered by debris falling from shelving in the basement. The Deputy Chief called for a Mayday as he was running out of air just after he told the crew to exit the basement. He was assisted from the structure, fell unconscious, and was rushed to a hospital. The victim's rescue, however, was hampered by the heightened fire conditions. The victim was recovered approximately 1 ½ hours later and transported to a local hospital where he was pronounced dead.

NIOSH investigators concluded that, to minimize the risk of similar occurrences, fire departments should:

- ***develop and implement standard operating procedures (SOPs) addressing emergency scene operations, including specific procedures for basement fires***
- ***ensure that ventilation is closely coordinated with the fire attack***
- ***ensure that a Rapid Intervention Team is in place before conditions become unsafe***
- ***develop and coordinate pre-incident planning protocols with mutual aid departments***
- ***implement joint training on response protocols with mutual aid departments***

Additionally,

- ***Municipalities should establish one central dispatch center to coordinate and communicate activities involving units from multiple jurisdictions***

- ***Municipalities should ensure that companies responding to mutual aid incidents are equipped with mobile and portable communications equipment that are capable of handling the volume of radio traffic and allow communications between all responding companies within their jurisdiction***

Incident Site

INTRODUCTION

On November 29, 2003, a 31-year-old male volunteer fire fighter (the victim) died while fighting a basement fire in a residential structure. On December 1, 2003, the U.S. Fire Administration (USFA) notified the National Institute for Occupational Safety and Health (NIOSH) of the fatality. On January 12, 2004 through January 15, 2004, three Safety and Occupational Health Specialists from the NIOSH Division of Safety Research investigated the incident. Meetings were conducted with the State Fire Marshal, Deputy State Fire Marshal, representatives from the State Fire Marshal's Office, a representative from the State's Fire Chiefs Association, a representative from the State's Fire Service Commission, and representatives from the State Critical Incident Stress Debriefing

Team. Interviews were conducted with officers and fire fighters who were at the incident scene. The NIOSH investigators reviewed the victim's training records, drawings of the building, and a career department's dispatch tapes. The victim's department did not have written standard operating procedures (SOPs) or dispatch tapes. The incident site was visited and photographed.

Department

This volunteer fire department has 22 uniformed fire fighters in 2 stations. It serves a population of approximately 7,500 in an area of about 28 square miles. Volunteer fire fighters are paid an hourly rate while on duty.

Training

The State where the incident took place has no minimum training requirements for fire fighters. The victim had more than 3 years of experience and had successfully completed numerous training courses such as: Fire Fighter I, first responder, search & rescue, self rescue, emergency medical technician, and pumps and hydraulics.

Building Information

The main structure was a 2-1/2 story wood balloon-frame residence with a basement. It was built in 1900 and had since been divided into five separate living units. The basement area was sectioned off into rooms by cabinets and shelving with debris and various materials throughout. It is believed the ceiling in the basement was a suspended ceiling system with 12-inch by 12-inch composite tiles stapled to a grid of wood furring strips.

In 1986, there were two additional 1-1/2 story wood-frame units attached to the rear of the main structure. Each of the seven units had their own natural gas meters.

The building had 5,378 square feet of living space. The residences were equipped with smoke detectors.

Weather

The National Weather Service reported that the winds at the regional airport approximately 10 miles from the incident scene averaged over 26 mph between 0300 and 0500 hours with gusts of over 42 mph. The temperature was in the upper 30's with scattered light rain showers.

Units for Initial Alarm

In this incident, a minimum of four volunteer and two career fire departments were dispatched; however, only those units directly involved in operations preceding the fatal event are discussed in the investigation section of this report.

Victim's Department

Personally Owned Vehicle (POV) (Captain [C1])
POV (Deputy Chief [IC])
Engine 4 (Officer, driver/operator, fire fighter)
Ladder 1 (Officer, driver/operator, fire fighter)

Rescue 1 (Victim, Fire Fighter #1)
Engine 2 (Officer, driver/operator)

Mutual Aid Departments for Initial Alarm
Engine 6 - Career (Deputy Chief [DC], driver/operator, Fire Fighter #2, Fire Fighter #3)
Engine 5 - Volunteer (Officer, driver/operator, 2 fire fighters)
POV – Volunteer (Chief [C2])
Ladder D1 - Career (Officer, driver/operator, 2 fire fighters)

INVESTIGATION

On November 29, 2003, a 31-year-old male volunteer fire fighter (the victim) died while fighting a basement fire in a residential structure. At approximately 0334 hours, the local police dispatch received a call of a structure fire in a residential occupancy, and dispatched the local volunteer fire department which included Engine 4, Engine 3, Engine 2, Ladder 1, and Rescue 1. Engine 3 (E3) was out of service due to mechanical failure; therefore, the victim and Fire Fighter #1 responded in Rescue 1 (R1).

A Captain (C1) was first to arrive on the scene in his personally owned vehicle (POV). He entered the front door to investigate and radioed the Incident Commander (IC), who was en route, that they had a working fire with heavy smoke coming from the basement. At approximately 0340 hours, the IC was notified by dispatch that Engine 3 was out of service. The IC immediately told the dispatch to have Engine 6 (E6) respond for mutual aid from a local career department. *Note: There were no alarm assignments or "Alarm Cards" for the units dispatched. The IC had to decide on the fire ground the units and departments that he wanted to respond to the incident.*

Upon arrival at the scene, the IC was told by C1 that everyone was out of the residence. At approximately 0343 hours, the IC called dispatch to request mutual aid from Engine 5 (E5), a volunteer company. As the IC and C1 were beginning their exterior size-up, E6 called the IC to request orders. *Note: The career department could only communicate with the IC on the radio in their apparatus. Their portable radios operated on a different frequency than the department for which they were providing mutual aid.* Engine 6 was now the first due pumper, so the IC had them report to the front of the structure upon their arrival at approximately 0344 hours. As the IC proceeded around the B-side of the structure, it was determined that they had a working basement fire. Rescue 1 had arrived on the scene and the IC had a face-to-face discussion with the Deputy Chief (DC) from E6. It was decided to advance a 1 ¾-inch hand line into the basement to find and attack the seat of the fire. The victim and Fire Fighter #1 received orders to assist the crew from E6 to advance the line into the basement.

The DC proceeded inside the structure with a thermal imaging camera (TIC) to check conditions and search or the fire. The conditions on the first floor did not require him to go on air. The DC could see down the entire stairs leading into the basement. He donned his air mask as he went down the narrow stairwell. The hallway at the bottom of the stairs turned back toward the center of the structure and it was lined with paint cans on shelves

(See Photo #1). Visibility was still good in the basement at this time. The DC opened a door to a room and there was minimal heat as the smoke banked down approximately 8 to 10 inches below the ceiling. The fire was sluggish along the ceiling coming from the C/D corner of the structure (see Diagram). The fire was in the suspended ceiling system overhead extending out from the C/D corner. *Note: This ceiling system would allow the fire to spread and gases to build up undetected in the void space overhead.*

The DC proceeded to the top of the stairs to communicate his findings to the IC and met Fire Fighter #2. He told Fire Fighter #2 that there was not much fire and to send down the hand line. The victim and Fire Fighter #1 advanced the uncharged hand line down the stairs into the basement (see Diagram). At approximately 0346, the DC called on his department's radio for the line to be charged. The fire fighters encountered some pressure problems with the hand line. The DC sent Fire Fighter #2 to check for kinks and informed Fire Fighter #3, who was stationed at the top of the stairs, not to send anyone else down because it was too crowded. Fire Fighter #2 found a kink in the hose line on the stairs and immediately restored pressure to the nozzle. During this time, the mutual aid chief (C2) arrived on the scene.

At approximately 0348 hours, Engine 5 (E5) arrived on the scene for mutual aid. The Lieutenant from E5 received orders to place a positive pressure ventilation (PPV) fan at the front door, leave it in the off position, and conduct a primary search on the third floor. The crew proceeded up the stairs and found light smoke conditions on the second and third floors. During this time, the victim and Fire Fighter #1 were taking turns on the nozzle while the DC reported to the IC that the fire was knocked down and requested ventilation. *Note: The DC had taken a radio from Fire Fighter #1 in order to communicate with the IC.* Upon the DC's request, the mutual aid chief (C2) started the PPV fan and walked around to the B-side to check the conditions. Fire fighters had already started venting the basement windows on B-side. Light colored conversion smoke flowed from the window confirming that they were hitting the fire in the basement and the water was being converted to steam.

At approximately 0350 hours the IC called and requested mutual aid from career department Ladder 1 (LD1) to provide a rapid intervention team (RIT). The Lieutenant from E5 called the IC to report all was clear on the third floor, but he did not receive a response. *Note: The Lieutenant's volunteer department had radios with channels that included the same frequency as the IC; however, the Lieutenant did not have communication with the IC due to his radio being on the wrong channel.* The smoke conditions improved as they opened the windows on the third floor. They could hear the PPV fan. The crew was using a TIC searching for extension, but could not find any in the attic area or knee walls of the third floor. *Note: Special attention was given to searching for extension because the house was balloon-frame construction.*

Within minutes, C2 began walking back toward the front of the structure. The smoke was now black and was pushing from the basement windows. At approximately the same time, conditions deteriorated as thick black smoke was pushing from under kitchen cabinets on the third floor located in the B/C corner. Visibility was near zero on the third and second floors as they decided to exit and receive additional orders.

During this time, the victim and Fire Fighter #1 were knocking the fire down in the basement. The smoke started to lift and visibility was returning just as the DC's low air alarm began to sound. The DC gave the TIC to one of the fire fighters on the nozzle and Fire Fighter #1's radio to Fire Fighter #2 as he began to exit in order to change out his air bottle. The conditions immediately got worse. Thick black smoke filled the entire basement area. *Note: It is believed that the crew in the basement was operating between the seat of the fire and the basement windows when the PPV fan was started and the basement windows were vented (see Diagram).* As the DC was trying to exit, he had difficulty finding the hose line because it made a loop in the small hallway at the bottom of the stairs and was covered by fallen debris. Visibility was now zero as the heat conditions became more intense. The DC told Fire Fighter #3 to abandon the basement. Fire Fighter #1 and Fire Fighter #3 exited the basement. The DC called for a Mayday at approximately 0407 hours, and again twice at 0408 hours on his department's portable radio. With no response and out of air, the DC manually activated his personal alert safety system (PASS), removed his regulator and placed his face next to the floor to try to breathe air. As he was crawling to find the stairs, another fire fighter assisted him outside where he fell unconscious and was rushed to a hospital where he was admitted for smoke inhalation.

The Lieutenant and two fire fighters from E5 had just made their way down to the first floor when fire fighters exiting the basement stated that a fire fighter was still in the basement. The crew from E5 immediately went to the basement. One fire fighter stayed at the bottom of the stairs as the Lieutenant and the other fire fighter searched for the victim. The Lieutenant yelled for the victim to manually activate his PASS with no response. They followed the hose line searching for the victim. Debris was falling on them and debris covered the basement floor and most of the hose line as they searched for the victim. Blue flames approximately two feet thick rolled across the basement ceiling. *Note: It is believed that two of the gas meters began to fail at this time due to the fire conditions.* The Lieutenant found the victim who requested assistance as he was trying to crawl without his mask. The Lieutenant yelled to his fire fighter for assistance. The fire fighter arrived within seconds to assist the victim who was now unresponsive. The two had great difficulty trying to drag the victim to the stairs due to the mounds of debris. Once they got the victim to the stairs they both called for Mayday without any response. As they were attempting to move the victim up the stairs, the basement became engulfed in flames (see Photo #2) and they were forced to leave.

It was determined through a roll call that the victim was still in the basement. Ladder D1 just arrived on the scene when the IC activated them as the RIT. The RIT entered the structure and passed the E5 crew in the hallway on the first floor who informed them that the victim was unresponsive and at the bottom of the stairs. Once outside, the E5 crew had to immediately remove their gear which was on fire due to the extreme heat conditions they endured as they attempted to rescue the victim.

The RIT proceeded about halfway down the basement stairs. They were met with extremely hot conditions and zero visibility. Flames were rolling across the ceiling towards the stairway which was acting as a chimney. The RIT was using a TIC, but it

would not register anything due to the intense heat conditions on the stairs. During this time the IC had called for an evacuation and sounded the air horns.

Fire conditions in the structure became untenable. *Note: At least two gas meters in the basement were compromised by the fire increasing the fire load (see Photo #3).* Operations moved to defensive tactics using master streams until the gas was shut off and the fire could be controlled. The victim was recovered at approximately 0630 hours, placed in an ambulance, and transported to a local hospital where he was pronounced dead.

CAUSE OF DEATH

The medical examiner reported the cause of death as smoke and soot inhalation.

RECOMMENDATIONS/DISCUSSIONS

(1) Recommendation #1: Fire departments should develop and implement standard operating procedures (SOPs) addressing emergency scene operations, including specific procedures for basement fires.

Discussion: Standard operating procedures (SOPs) should be developed addressing emergency scene operations. The SOPs for emergency operations should cover specific operations such as ventilation, water supplies, and basement fires. Basement fires present a complex set of circumstances, and it is important that SOPs are developed and followed to minimize the risk of serious injury to fire fighters. The importance of ventilation when attacking basement fires cannot be overemphasized. Fire can quickly spread upward into the structure causing potential problems such as a flashover, back draft, or weakening of the structure. Ventilation timing is extremely important and must be carefully coordinated with both fire attack and ventilation crews. Ideally, ventilation should occur just ahead of interior crews advancing their hose lines. Properly ventilating the heat and smoke from buildings can reduce the possibilities of potentially hazardous situations for fire fighters. The fire fighters performing ventilation tasks should be in communication with the fire fighters attacking the fire or entering the structure to coordinate their efforts. The SOPs should be in written form and be included in the overall risk management plan for the fire department. If these procedures are changed, appropriate training should be provided to all affected members. The department involved in this incident did not have written SOPs at the time of the investigation.

(2)

Recommendation #2: Fire departments should ensure that ventilation is closely coordinated with the fire attack.

Discussion: Chapter 10 of the *Essentials of Fire Fighting*, 4th edition, states that "ventilation must be closely coordinated with fire attack." To reduce vertical extension, direct ventilation of the basement during fire attack is necessary. This can be accomplished in several ways. Horizontal ventilation can be employed to vent heat, smoke, and gases through wall openings such as doors and windows, even if the windows are below ground-level in wells. Natural pathways such as stairways can also be used to vent the basement area provided the means used to ventilate the heat and smoke do not place other portions of the building in danger. As a last resort, the basement can be vented by cutting a hole in the floor near a ground-level opening such as a door or window. The heat and smoke can then be forced from the basement through the exterior opening using mechanical ventilation.

Forced ventilation introduces air at such great volumes that it can cause the fire to intensify or spread. In this incident, the fire had already been knocked down when ventilation was requested. Horizontal ventilation was completed by knocking out the basement windows on the B-side of the structure. Horizontal ventilation does not release the heat and smoke directly above the fire; therefore, it is imperative that horizontal ventilation is coordinated with the interior attack crew to ensure that it doesn't block their escape routes. The crew that was operating inside the basement was between the windows and the seat of the fire. When the forced positive pressure ventilation took place, they were in the direct exit path of the products of combustion.

(3)

Recommendation #3: Fire departments should ensure that a Rapid Intervention Team is in place before conditions become unsafe.

Discussion: A Rapid Intervention Team (RIT) should be positioned to respond to every fire. The team should report to the officer in command and remain at the command post until an intervention is required to rescue a fire fighter(s). The RIT should have all the tools necessary to complete the job, e.g., a search rope, first-aid kit, and a resuscitator. The RIT team should be comprised of fresh, well-rested fire fighters, and be positioned and ready to respond when a fire fighter(s) is down or in trouble. In this incident, a mutual aid company was called to provide RIT services; however, they did not arrive until after the victim became trapped.

(4)

Recommendation #4: Fire departments should develop and coordinate pre-incident planning protocols with mutual aid departments.

Discussion: NFPA 1620 provides guidance to assist departments in establishing pre-incident plans. Pre-incident planning that includes agreements formed by a coalition of all involved parties including mutual aid fire departments, emergency medical services companies, and police, will present a coordinated response to emergency situations, and may save valuable time by a more rapid implementation of pre-determined protocols.

(5)
Recommendation #5: Fire departments should implement joint training on response protocols with mutual aid departments.

Discussion: Mutual aid companies should train together and not wait until an incident occurs to attempt to integrate the participating departments into a functional team. Differences in equipment and procedures need to be identified and resolved before an emergency occurs where lives may be at stake. Procedures and protocols that are jointly developed, and have the support of the majority of participating departments, will greatly enhance overall safety and efficiency on the fire ground. Once methods and procedures are agreed upon, training protocols must be developed and joint-training sessions conducted to relay appropriate information to all affected department members.

In this incident, a minimum of four volunteer and two career fire departments were on the scene. Coordination of fire ground efforts would have been enhanced if protocol planning, communication procedures (such as radio frequency/channel selection), and training had taken place among mutual aid departments.

Additionally,

(6) Recommendation #6: Municipalities should establish one central dispatch center to coordinate and communicate activities involving units from multiple jurisdictions.

Discussion: An effective radio communication system is a key factor in fire department operations. The communication system, or central dispatch center, is used for receiving notification of emergencies, alerting personnel and equipment, coordinating the activities of the units engaged in emergency incidents, and providing nonemergency communications for the coordinating fire departments. The dispatch system must be able to identify the type and number of units due to respond to the type of incident in advance based on risk criteria and unit capabilities. Because there were not pre-determined alarm assignments, or an "alarm card," for the units dispatched, the incident commander had to decide which units and departments that he wanted to respond to the incident. Fire communications centers should also be staffed with operators who are familiar with fire department operations and equipment. The central dispatch center could then also monitor fire ground activity and inform command of time intervals or of possible missed transmissions such as Maydays. A central dispatch center equipped with regional mutual aid channels could serve multiple jurisdictions. This type of system would provide operational advantages in the communication system, reflect a more functional mutual

aid system, and reduce overall costs of operating centers in individual jurisdictions. Having a pre-determined response for apparatus arranged by district, address or by type of incident, makes the Incident Commander's and the dispatcher's job much easier. The assignment lists the apparatus slated to respond to the incident and should take into account apparatus that are out of service by filling in for such units with similar units. In this incident, once Engine 3 was determined to be out of service, an alarm card plan would have dispatched another engine in its place.

(7)

Recommendation #7: Municipalities should ensure that companies responding to mutual aid incidents are equipped with mobile and portable communications equipment that are capable of handling the volume of radio traffic and allow communications between all responding companies within their jurisdiction.

Units responding to or engaged at incidents should have the necessary radio frequencies/channels to be in contact with other units providing mutual aid. These units should also have the capability to monitor the fire ground activities while en-route. During this incident, many of the units could not communicate with the IC or the local dispatch center on either their portable or mobile radios.

9. Diagram and Photographs

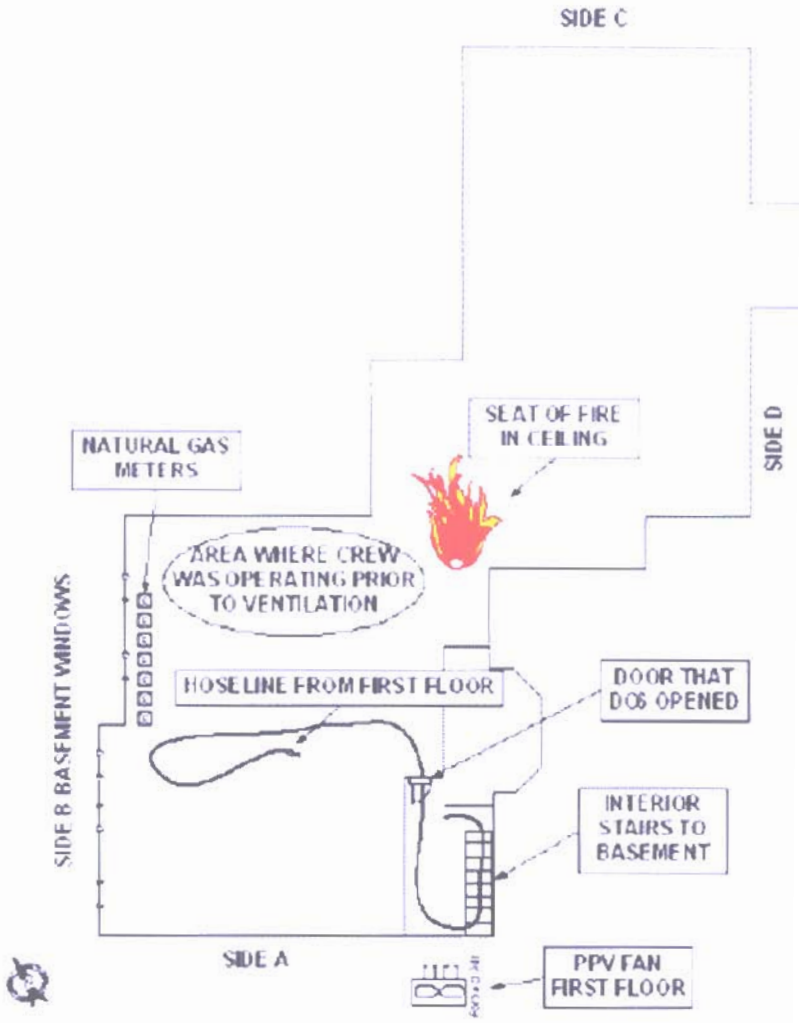


Diagram. Basement layout, aerial view

Photo 1. Narrow hallway at bottom of basement stairs.

Photo 2. B-side basement windows engulfed in flames.

Photo 3. The two compromised gas meters are on the left.

Residential Basement Fire Claims the Life of Career Lieutenant - Pennsylvania

SUMMARY

On January 9, 2004, a 45-year-old male career lieutenant (the victim) sustained serious injuries after he partially fell through the first floor while fighting a residential basement fire. The victim was among the first on the scene, and he reported light smoke coming from a two-story, middle row town home. The victim entered the structure without his self contained breathing apparatus (SCBA) to investigate, and reported to the Incident Commander (IC) that it was a basement fire. The victim exited the structure to assist his crew in advancing a 1 3/4-inch hose line into the structure through the front door of the first floor. The victim's crew protected the first floor and looked for fire extension as another crew attacked the fire through a rear entrance into the basement. The victim exited the structure a second time, presumably for air, and spoke to another member who was conducting ventilation. The victim went back into the structure and was trapped on his third attempt to exit when he partially fell through the floor. Rescue crews found and removed the victim within minutes and he was transported to an area hospital where he died from his injuries seven days later.

NIOSH investigators concluded that, to minimize the risk of similar occurrences, fire departments should:

- ***require, and all officers should enforce the requirement, that all fire fighters wear their SCBAs whenever there is a chance they might be exposed to a toxic or oxygen-deficient atmosphere, including during the initial assessment***
- ***ensure fire fighters are trained to recognize the danger of operating above a fire***
- ***ensure that team continuity is maintained with two or more fire fighters per team***

Front of Structure

INTRODUCTION

On January 9, 2004, a 45-year-old male career lieutenant (the victim) sustained serious injuries after he partially fell through the first floor while fighting a residential basement fire. The victim died from these injuries seven days later. On January 16, 2004, the U.S. Fire Administration (USFA) notified the National Institute for Occupational Safety and Health (NIOSH) of the fatality. On March 10, 2004 through March 12, 2004, two Safety and Occupational Health Specialists from the NIOSH Division of Safety Research investigated the incident. Meetings were conducted with the Fire Commissioner, the Fire Department's Operations Officer, representatives from the Fire Marshal's Office, and representatives from the International Association of Fire Fighters. Interviews were conducted with officers and fire fighters who were at the incident scene. The NIOSH investigators reviewed the department's standard operating procedures (SOPs), the fire marshal's report, victim's training records, and drawings of the building. The incident site was visited and photographed.

Department

The career department involved in this incident is comprised of 2,300 uniformed fire fighters. The department serves a population of approximately 1.7 million residents in a geographic area of about 130 square miles.

Training

The fire department provides all new recruits with a 15-week training conducted at the city's Fire Academy. The victim had more than 14 years of experience and had successfully completed numerous training courses such as: Fire Fighter I and II, Fire Instructor I, Incident Command System, Hazardous Materials Operations, Rapid Intervention, and SCBA orientation.

Building Information

The structure was a two-story, middle row, 16ft. x 45ft. brick dwelling. It was built in the 1930's, prior to any existing building codes, and had a full basement with a ground level entrance in the rear of the structure. The flooring system where the incident occurred consisted of a parquet wood floor approximately 3/8-inch thick covering a wood plank sub-floor approximately 3-inches wide by 3/4-inch thick nailed to 2 1/2-inch by 8-inch floor joists that were 16-inches on center. The residence was equipped with smoke detectors.

Equipment

Additional units were dispatched; however, only those units directly involved in operations preceding the fatal event are discussed in the investigation section of this report.

Engine 72 (Victim, driver/operator, 2 fire fighters)
Engine 51 (Officer, driver/operator, 2 fire fighters)
Ladder 29 (Officer, driver/operator, 3 fire fighters)
Ladder 22 (Officer, driver/operator, 3 fire fighters)
Ladder 8/Rapid Intervention Team (Officer, driver/operator, 3 fire fighters)
B2 (Battalion Chief 2, Chief's Aide)

INVESTIGATION

On January 9, 2004, a 45-year-old male career lieutenant (the victim) sustained serious injuries after he partially fell through the first floor while fighting a residential basement fire. At 0626 hours, Engine 72 (E72), Engine 51 (E51), Ladder 29 (L29), Ladder 22 (L22), and Battalion Chief 2 (IC) were dispatched to a residential dwelling for a reported fire. At 0629 hours, E72 arrived on the scene and the victim reported light smoke coming from a two-story, middle row, 16ft. x 45ft. dwelling (see Cover Photo). The victim entered the structure without his self contained breathing apparatus (SCBA) to investigate, and reported to the Incident Commander (IC) that it was a basement fire. The victim exited the structure and placed E72 and L29 in service at the front of the structure. Two fire fighters and the victim from E72 advanced a 1 3/4-inch hose line into the structure (see Diagram 1), while L29 placed ground ladders to the second floor to conduct ventilation. One of the fire fighters informed the victim that the floor was very hot and physically weakened or "spongy" as they advanced the hand line. The victim notified the IC that they had a basement fire, and at approximately 0630 hours, the IC arrived on scene and placed an additional engine and ladder into service.

E51 and L22 were operating at the rear of the structure with the IC. L22 was assigned search and rescue, while E51 made entry into the basement through a door at ground level (see Photo 1). Entry was impeded approximately 10 feet inside the basement door due to an old appliance and debris which was stacked about five feet high over the entire basement floor (see Diagram 2).

E51 informed the IC that they were working on clearing debris to access the fire. The IC called the victim to inform him that E51 would attack the fire from the basement level. The Captain from L29 responded for the victim and confirmed the order at 0635 hours. *Note: The Captain and the victim were talking on the front porch of the structure after the victim exited the structure for the second time. The victim did not have his SCBA on and was leaning over the banister attempting to catch his breath. The Captain told the victim to get off of the porch and get some fresh air.* The victim went back inside a third time as the Captain was working on ventilating the basement. The Captain from L29 then radioed his crew to tell them to vent the porch floor after they finished venting the roof. *Note: The porch floor is also the ceiling over the north section of the basement (see Diagram 2).*

At 0641 hours, the IC called the Captain from Ladder 29 and requested that he take command of the front of the structure and to keep him posted on the fire conditions and ventilation of the front of the structure. The IC stated that E51 was making progress on the fire at this time. The victim, two of his fire fighters, and a fire fighter from L29 were stationed at the door of the stairs leading to the basement with a 1 3/4-inch hand line awaiting instructions. They were on their hands and knees to avoid the heat and smoke in near zero visibility conditions. At 0642 hours, the IC called the victim to tell him to hold his ground on the first floor and that E51 was attacking the fire from the basement. The IC wanted the victim to guard against fire extension on the first floor and to attempt hydraulic ventilation by flowing water through a window on the first floor to draw the

smoke out of the window. At 0643 hours, the victim responded "That's affirmative, we can do that." The victim turned around to exit the first floor and tripped over the hand of one of his fire fighters and stumbled towards the front door. Fourteen seconds after his last transmission, the victim keyed his radio for 4 seconds without speaking. *Note: The victim did not make it out of the structure. It is believed that the victim's foot fell through the floor at this time (see Photos 2 and 3).*

After the crew from E72 did not hear from the victim for a couple of minutes, one fire fighter started to crawl towards the front door to check for the victim. As he was nearing the threshold to the living room from the dining room, his hand penetrated through the floor and the fire lit up right in front of him. The crew put water on the fire and radioed for the victim at 0646 hours with no response. The crew's exit path through the front door was cut off by the fire. They turned around, went down the basement stairs, and exited through the basement door in the rear of the structure. Upon exiting, the fire fighter from L29 with E72 radioed an "Urgent" message then followed up with the IC at 0650 hours that the crew from the first floor exited, but that they didn't know the location of the victim. The IC deployed the Rapid Intervention Team (RIT) at 0651 hours to search for the victim. The victim was found by a member of the RIT and a fire fighter from L29 face down with one of his legs through a hole in the floor at 0701 hours (see Photo 4). Within a few minutes the victim was removed and transported to an area hospital where he died seven days later from his injuries.

Cause of Death

The medical examiner lists the cause of death as smoke and soot inhalation and thermal burns.

RECOMMENDATIONS/DISCUSSIONS

(1) Recommendation #1: Fire departments should require, and all officers should enforce the requirement, that all fire fighters wear their SCBAs whenever there is a chance they might be exposed to a toxic or oxygen-deficient atmosphere, including during the initial assessment.

Discussion: Since carbon monoxide (CO) is given off in varying quantities during all fires, and other toxic materials are typically present, it is paramount that officers enforce and fire fighters follow the department's guidelines for the wearing of masks at structure fires. In this incident, a number of fire fighters reported not wearing their masks inside the structure even while encountering moderate smoke conditions. Far more fire deaths occur from carbon monoxide than from any other toxic product of combustion. This

colorless, odorless gas is present in every fire. The poorer the ventilation and the more inefficient the burning, the greater the quantity of carbon monoxide formed.

Table 1 lists the toxic effects of carbon monoxide. Concentrations of carbon monoxide in air above five hundredths of one percent (0.05 percent) or 500 parts per million can be dangerous. When the level is more than 1 percent, unconsciousness and death can occur without physiological signs. Therefore, the signs and symptoms outlined in Table 1 are not good indicators of safety.

The toxicity of carbon monoxide (CO) varies with the length of exposure, the concentration, breathing and heart rate. CO causes tissue hypoxia (low oxygen content) by preventing the blood from carrying sufficient oxygen. CO combines much more readily with the oxygen-carrying sites on the hemoglobin molecule than oxygen itself. The carboxyhemoglobin thus formed is unavailable to carry oxygen. Toxicity of CO varies with the percent carboxyhemoglobin in the blood. Reactions to CO poisoning vary with the individual and include headache, vertigo, difficulty breathing, confusion, convulsions, and coma. A 1 percent concentration of carbon monoxide in a room will cause a 50 percent level of carboxyhemoglobin in the blood stream in 2 1/2 to 7 minutes. A 5 percent concentration can elevate the carboxyhemoglobin level to 50 percent in only 30 to 90 seconds. Because the newly formed carboxyhemoglobin may be traveling throughout the body, a person previously exposed to a high level of carbon monoxide may react later. Carboxyhemoglobin levels greater than 55 percent usually are fatal; 40 percent levels are associated with collapse and syncope (a faint); at 15 percent to 25 percent headache and nausea may be present. If fire fighters are potentially affected by carbon monoxide, they should not be allowed to continue with firefighting operations. If fire fighters suspect they have been exposed to carbon monoxide, they should immediately notify their officer or the IC. In this incident, the victim entered the structure to conduct an initial assessment and continued to operate without a SCBA. His exposure to carbon monoxide started when he first entered the structure and may have affected his decision making process throughout the incident.

Carbon Monoxide (CO)(ppm)	Carbon Monoxide in air (percent)	Symptoms
100	0.01	No symptoms-no damage.
200	0.02	Mild headache; few other symptoms.
400	0.04	Headache after 1 to 2 hours.
800	0.08	Headaches after 45 minutes; nausea, collapse, and unconsciousness after 2 hours.
1,000	0.1	Dangerous; unconscious after 1 hour.
1,600	0.16	Headache, dizziness, nausea after 20 minutes.
3,200	0.32	Headache, dizziness, nausea after 5 to 10 minutes; unconsciousness after 30 minutes.

6,400	0.64	Headache, dizziness, nausea after 1 to 2 minutes; unconsciousness after 10 to 15 minutes.
12,800	1.28	Immediate unconsciousness, danger of death in 1 to 3 minutes.

Table 1. Toxic Effects of Carbon Monoxide

(2)
Recommendation #2: Fire departments should ensure fire fighters are trained to recognize the danger of operating above a fire.

The danger of being trapped above a fire is greatly influenced by the construction of the burning building. Of the five basic building construction types (fire resistive, noncombustible, ordinary construction, heavy timber, and wood frame) the greatest danger to a fire fighter who must operate above the fire is posed by wood-frame construction. Vertical fire spread is more rapid in this type of structure. Flames may spread vertically and trap fire fighters operating above the fire, in four ways: up the interior stairs, through windows (auto exposure), within concealed spaces, or up the combustible exterior siding. Extreme caution must be used to determine if the structural stability of the flooring system is adequate to facilitate the operations. In this incident, the floor was noticeably weakened as the victim's crew advanced the initial hand line, indicating that the floor was not structurally sound to support operations on the first floor above the fire. As soon as fire fighters become aware of structural instability, they should immediately exit the structure and notify the IC.

(3)
Recommendation#3: Fire departments should ensure that team continuity is maintained with two or more fire fighters per team.

Discussion: Each fire fighter must be assigned to a team of two or more and be given specific assignments to help reduce the chance of injuries. Team continuity relies on some very important key factors: knowing who is on your team and the team leader, staying within visual contact at all times (if visibility is obscured then teams should remain within touch or voice contact distance of each other), communicating your needs and observations to the team leader, rotating to rehab and staging as a team, and watching your team members (practice a strong "buddy-care" approach). These key factors help to reduce serious injury or even death resulting from the risks involved in fire fighting operations by providing personnel with the added safety net of fellow team members. Company or crew members should enter and exit the environment together.

10. Photographs AND Diagrams

Photo 1. Rear of structure

Photo 2. Floor area consumed by fire

Photo 3. View from basement of floor area consumed by fire

Photo 4. Living room floor

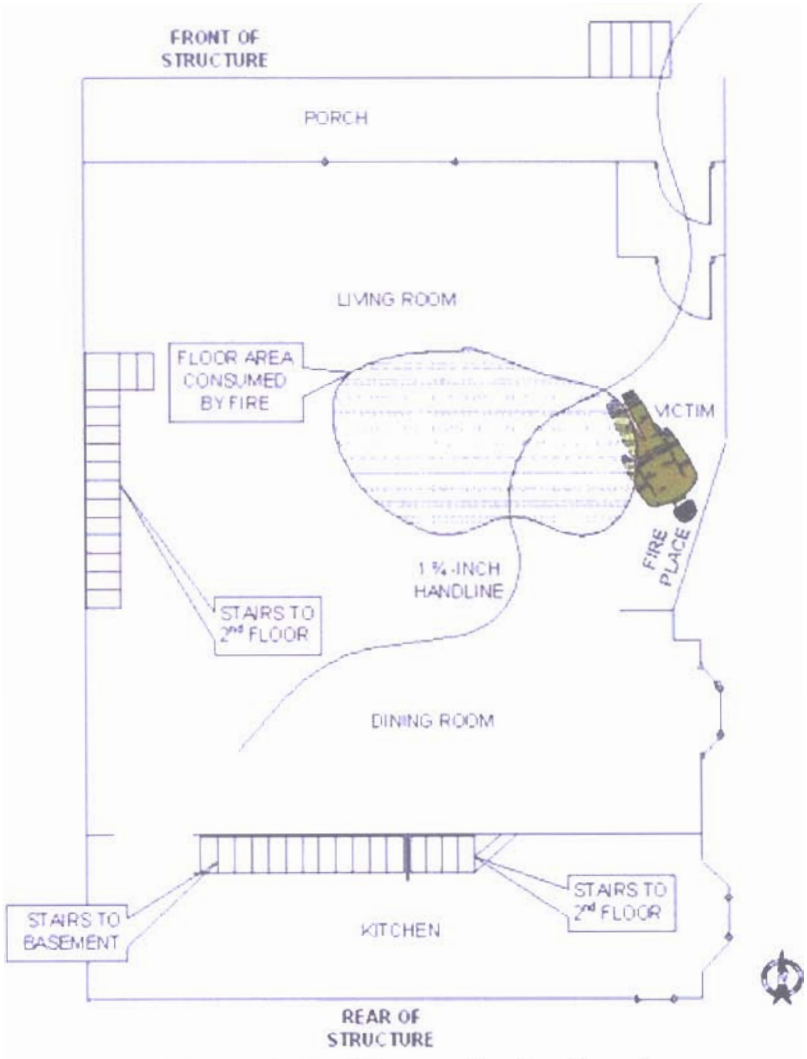


Diagram 1. First floor aerial view layout

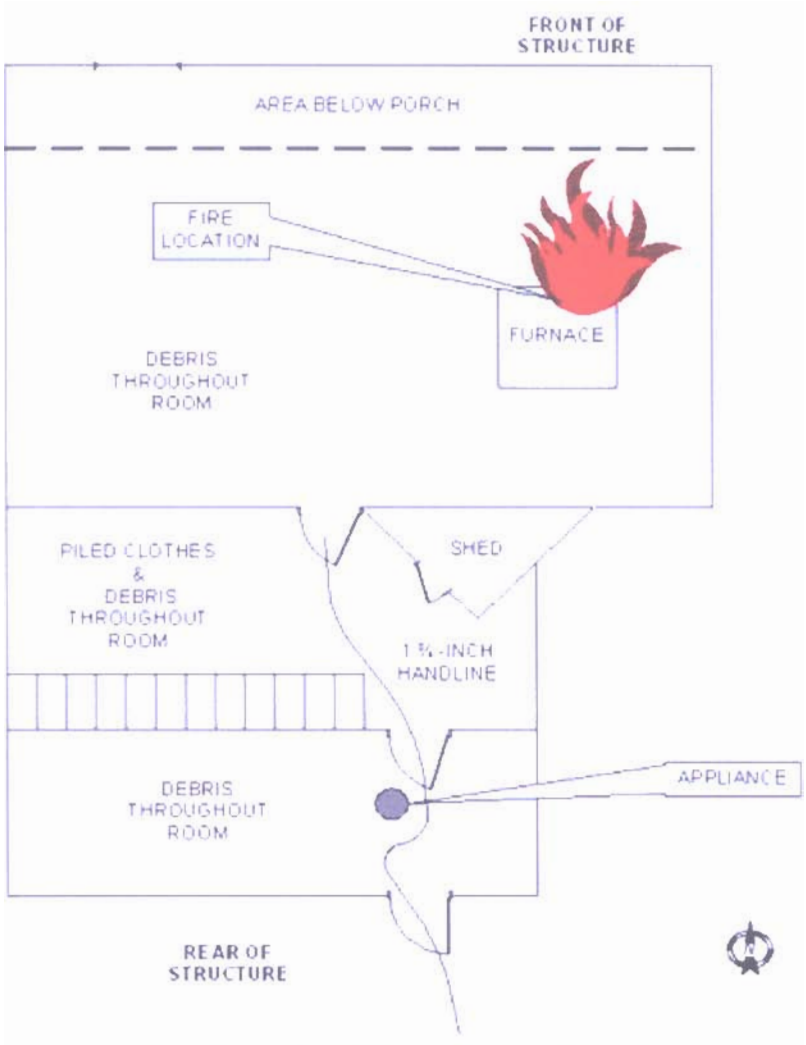


Diagram 2. Basement aerial view layout